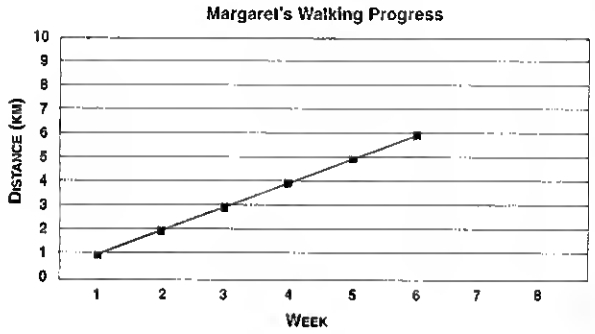
DIAGNOSTIC TEST

Use the answer sheet provided on page 13.

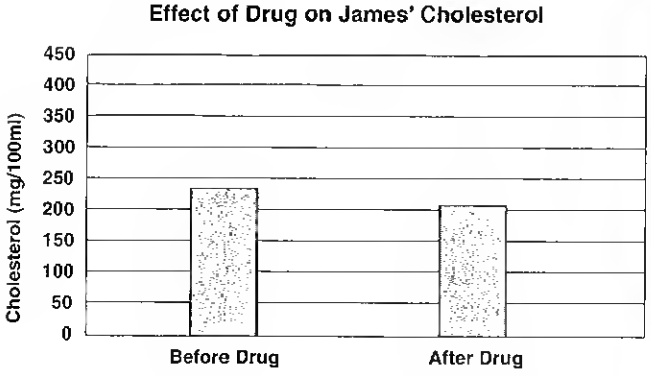
1. A scientist wants to know if a new drug causes weight loss in rats. How could the scientist determine the drug's effect?
   A by measuring the rats' temperature
   B by measuring the rats' mass
   C by measuring the rats' length
   D by measuring the rats' food

2. Margaret decided to begin a new exercise routine that includes walking daily. Each week she walks a little farther than the week before. If Margaret continues adding distance at the same rate, how far will she walk by the end of week eight?



   A 6 km
   B 7 km
   C 8 km
   D 9 km

3. James' doctor wants him to lower his cholesterol from 240 mg/100 ml to 180 mg/100 ml using a new drug. After four weeks on the drug, the doctor recorded these results:



   Based on this data you can infer _____.
   A the new drug had no effect on James' cholesterol
   B the new drug had some effect on James' cholesterol
   C James should stop taking the new drug
   D James' cholesterol remained the same

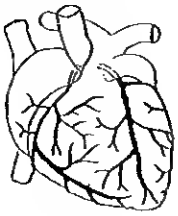
4. What is the temperature according to the thermometer?
   A 10°C
   B 10°F
   C 22°F
   D 22°C

5. Ray wants to know how fast he can ride on his bike. He does not have a speedometer, so he decides to calculate his speed using distance and time. He rides his bike around a 1.6 kilometer track in 4 minutes. What is Ray's average speed in km/hr?

   $\left(\text{speed} = \frac{\text{distance}}{\text{time}}\right)$

   A 6.4 km/hr
   B 24 km/hr
   C 0.4 km/hr
   D 2.4 km/hr

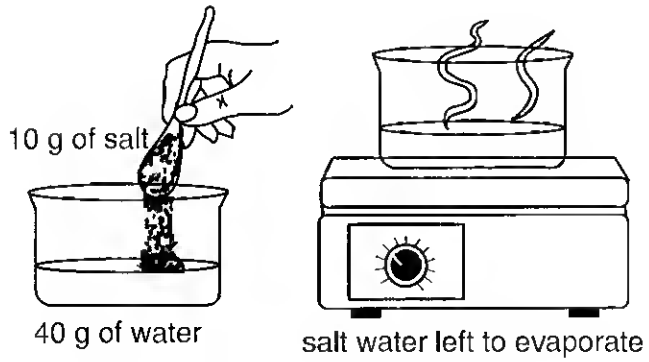
6. The heart is a/an _____.



A cell
B tissue
C organ
D system

7. A/An _____ is an instrument that measures the wind speed using a series of cups mounted on a shaft that spins freely.
A anemometer
B wind vane
C barometer
D thermometer

8. In an experiment, 10 grams of salt are dissolved in 40 grams of distilled water. A hot plate is then used to heat the water until it evaporates. How much salt will be left when all of the water has evaporated?



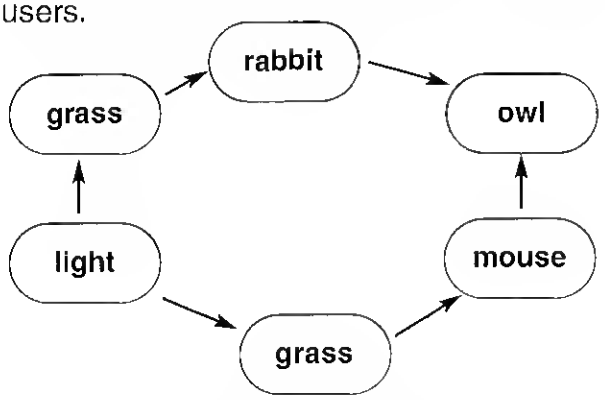
A 0 grams
B 50 grams
C 40 grams
D 10 grams

9. Which body system is made up of glands that send chemical messages to other parts of the body?
A cardiovascular
B muscular
C respiratory
D endocrine

10. The water flow down the Neuse River has decreased 75% over the last 5 years. What can you infer from this information?
A that it is raining more than usual
B that it is raining less than usual
C that someone is removing water from the river
D the rainfall rate has remained constant

11. A car travels 300 km south in 4 hours. What is its velocity?
(velocity = speed [distance/time] + direction travelled)
A 75 km/hr, south
B 1,200 km/hr, south
C 1,200 km/hr
D 75 km/hr

Look at the food web below. The arrows point from the energy providers to the energy users.



12. The source of energy for all the energy providers in this food web is _____.
A grass
B the owl
C the mouse
D light

13. Your skin would be considered a(n) _____.
    A cell
    B tissue
    C organ
    D system

14. Which of the following is a non-living factor in an organism's environment?
    A deer
    B water availability
    C food
    D predators

15. Which of the following devices would you use to measure the temperature of a liquid?

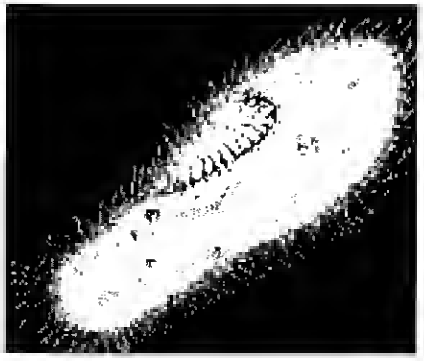
A 

B 

C 

D 

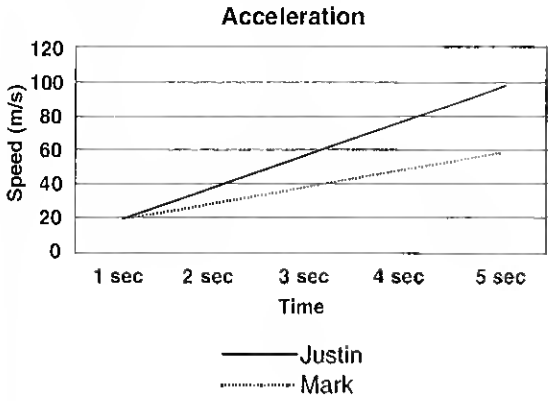
Use the following picture to answer questions 16 and 17.



16. In the above organism, what is the name of the hair-like structures?
    A flagella
    B cilia
    C pseudopodia
    D centrosomes

17. In the organism, what is the function of the hair-like structures?
    A locomotion
    B digestion
    C absorption
    D respiration

18. What can you conclude from the data below?



    A Mark is accelerating faster than Justin.
    B Justin is accelerating faster than Mark.
    C Mark's speed is increasing faster than Justin's.
    D Justin's velocity is greater than Mark's.

19. Which of the following does ***not*** affect the speed of a ball rolling downhill?
    A the weight of the ball
    B the slope of the hill
    C the bumpiness of the hill
    D the lift of the hill

20. Ocean Food Chain

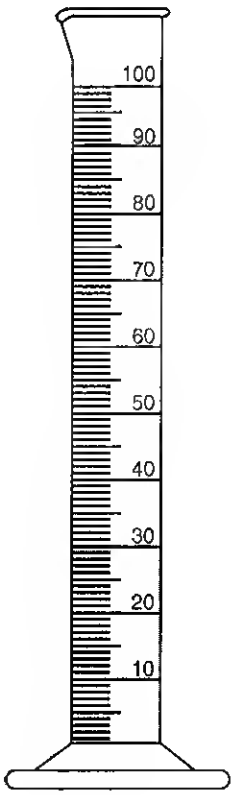
plankton ➔ shrimp ➔ _____ ➔ whale

The missing link in the food chain is _____.
    A sun
    B fish
    C seaweed
    D shark

21. The diagram that shows how energy flows through a food chain is_____.
    A sun ➔ producer ➔ consumer ➔ herbivore
    B carnivore ➔ consumer ➔ herbivore ➔ sun
    C sun ➔ producer ➔ herbivore ➔ carnivore
    D sun ➔ producer ➔ carnivore ➔ herbivore

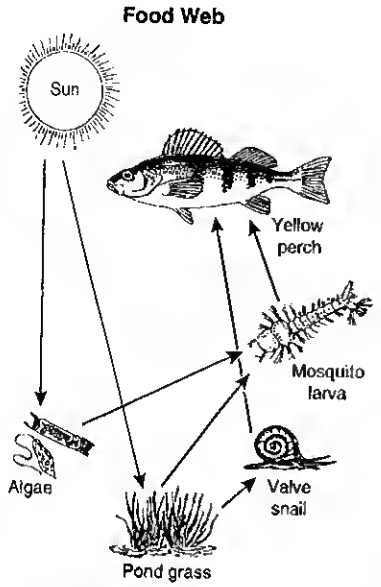
22. Which answer ***best*** describes the human heart?
    A It has two atria and one ventricle. It pumps blood directly into the veins.
    B It has one atrium and one ventricle. It is composed of cardiac muscle.
    C It has one atrium and two ventricles. It is composed of skeletal muscle.
    D It has two atria and two ventricles. It pumps blood directly into the arteries.

23. If 12 ml of corn syrup were added to the water in this graduated cylinder, the total volume of the liquid would be_____.



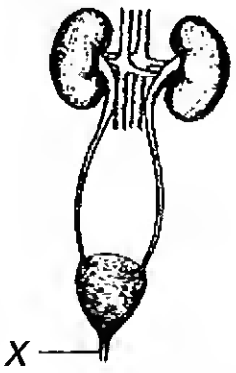
    A 57 milliliters
    B 42 milliliters
    C 44 milliliters
    D 52 milliliters

24. If the pond grass in the diagram died, what would the effects on other organisms be?



    A There would be no change to the other organisms.
    B There would be less algae in the pond.
    C The fish would die.
    D There would be more mosquito larva.

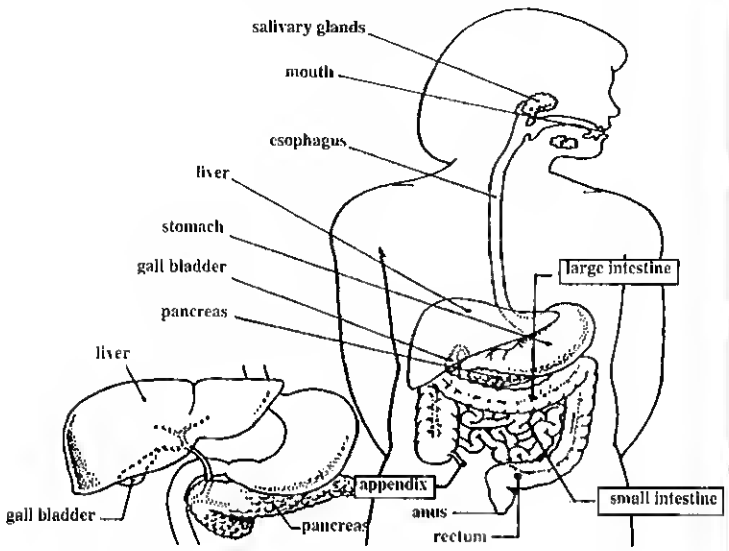
25. What is the main function of organ X in the following diagram?



    A It filters waste from the body.
    B It transports urine out of the body.
    C It is a storage place for urine.
    D It secretes hormones.

26. Which body system carries food to the cells and waste away from the cells?
    A respiratory
    B digestive
    C cardiovascular
    D muscular

Use the following diagram to answer questions 27–28.



27. Where does the food enter after it has been swallowed?
    A the large intestine
    B the liver
    C the esophagus
    D the stomach

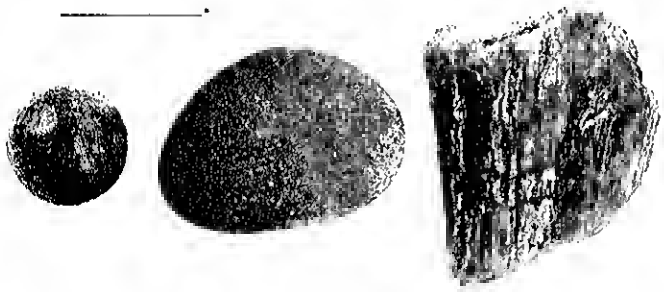
28. Which organ shows where most absorption occurs?
    A the esophagus
    B the liver
    C the stomach
    D the small intestine

29. The human nervous system is made up of the brain, the spinal cord, and _____.
    A neurons
    B endocrine glands
    C heart muscle
    D digestive organs

30. Which of the following diseases is ***not*** caused by a virus?
    A AIDS
    B strep throat
    C measles
    D chicken pox

31. Which of the following is a chemical property of matter?
    A Liquid water changes to ice.
    B A student cuts aluminum foil.
    C A student places copper shot in a beaker of water.
    D The teacher burns magnesium metal.

32. Each of these rocks is dropped from the top of a ramp at the same time. The rock that will reach the ground first is _____.



1 **2** **3**

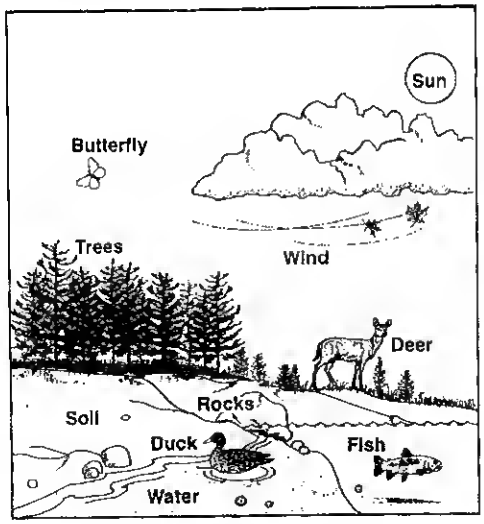
    A They will reach the ground at the same time.
    B rock 3
    C rock 2
    D rock 1

33. The mushrooms in this diagram are an example of _____.

A predators
B parasites
C herbivores
D decomposers

34. Which of these would ***probably*** produce the least amount of friction?
A skis on snow
B tires on a gravel road
C bare feet on carpet
D shoes on grass

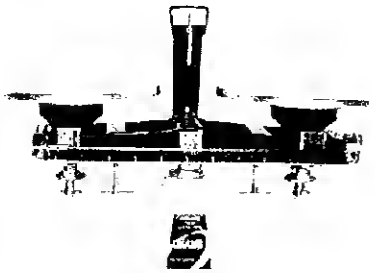
35. Some of the abiotic elements of this ecosystem are _____.



A trees, deer and fish
B soil, duck and butterfly
C soil, water and sun
D fish, water and wind

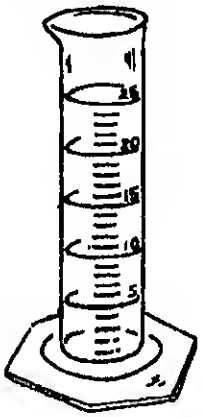
36. The ***best*** tool to measure mass is _____.

A



B

C



D

37. Vaporization that takes place at the surface of a liquid is called _____.
A boiling
B sublimation
C evaporation
D condensation

38. Which of the following is a mixture?
    A soda
    B salt
    C sugar
    D water

39. Forces that are opposite and equal are _____.
    A balanced
    B frictional
    C sliding
    D unbalanced

40. Which of the following can reduce the effect of friction?
    A wheels
    B carpet
    C a push
    D a pull

41. In which situation is ***no*** work done?
    A carrying a football down the field
    B kicking a football up into the air
    C picking up a football off the field
    D throwing a football up into the air

42. Which of the following is a quantitative observation?
    A The dress is red.
    B The table looks like it is made of wood.
    C It must have rained because the street is wet.
    D The table is 4 feet long.

43. You collect a pile of rocks from a playground. You separate them based on bumpiness or smoothness. You are sorting by _____.
    A color
    B weight
    C texture
    D smell

44. Climate is weather considered over a long period of time. An important factor that determines climate is _____.
    A temperature
    B fog
    C clouds
    D snow

45. Cooler air is _____.
    A more dense than warm air
    B less dense than warm air
    C the same density as warm air
    D none of the above

46. Which of the following occurs when more water molecules are leaving the liquid state than are returning?
    A condensation
    B evaporation
    C rain
    D frost

47. A moving cold air mass makes a _____.
    A cold front
    B warm front
    C stationary front
    D tropical front

48. Two people are pulling a person in a sled. Which of the following would make their work easier?

    A to reduce the weight of the rider
    B to pull harder
    C to pull in the opposite direction
    D to create a balanced force

49. Which biome is found in the eastern United States and is characterized by trees that lose their leaves in the fall and winter? These trees include oaks, maples, elms, and birches.
    A grasslands
    B deciduous forest
    C tundra
    D tropical forest

50. An object, such as a plane, passing over the United States from the North Pole to the equator will veer off in the direction of the Pacific Ocean. This apparent turning of objects moving in straight lines is called _____.
    A the Coriolis effect
    B convection cells
    C relative humidity
    D tornadoes

51. When wild turkeys and deer need acorns for food, this is a good example of _____.
    A population
    B competition
    C communication
    D reproduction

52. An area characterized by slight rainfall, extremely cold temperatures, grasses, and reindeer is called _____.
    A the temperate rainforest
    B the grasslands
    C the desert
    D the tundra

53. A group of living things of the same species in a particular area is called _____.
    A a population
    B a community
    C a family
    D a biome

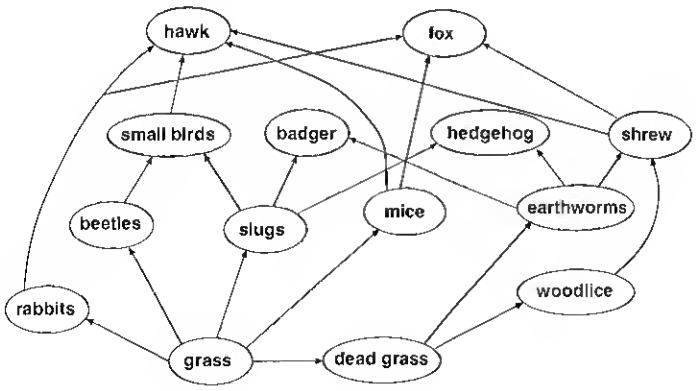
54. The biome where large animals graze is called the _____.
    A taiga
    B tundra
    C deciduous forest
    D grasslands

55. The biome that is hot and wet is called the _____.
    A tropical rainforest
    B taiga
    C deciduous forest
    D desert

56. Most of the precipitation that falls on land _____.
    A soaks in
    B runs off
    C returns to the atmosphere
    D stays on the land

57. What is the source of energy for the Earth's water cycle?
    A the wind
    B the sun
    C gravity
    D the magnetic field

Use the food web below to answer question 58.



58. Which statement is true about the food web?
    A Small birds, badgers, and shrews are secondary consumers.
    B Earthworms, shrews, and foxes are tertiary consumers.
    C Rabbits, beetles, and hedgehogs are primary consumers.
    D A correct food chain would be dead grass ➡ earthworms ➡ mice ➡ fox.

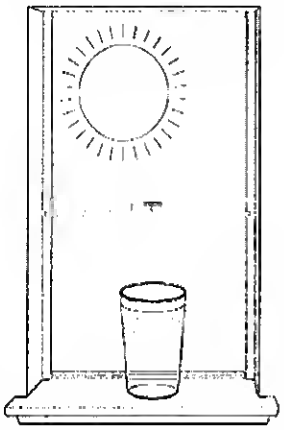
59. If two different species in the same habitat require the same type of nesting site, both species will ***most likely*** _____.
    A interbreed and share nesting sites
    B compete for the nesting site
    C change their nesting site requirements
    D use the nests of other bird species

60. The taiga biome is characterized by _____.
    A long, cold winters, frozen subsoil, and no trees
    B cold winters, coniferous trees and a lot of snow
    C heavy rainfall, broad-leaved trees and hot temperatures
    D hot days, cool nights and little precipitation.

61. According to the nitrogen cycle, how does nitrogen from the atmosphere become used by plants?
    A Animal wastes carry it to the soil.
    B Bacteria form nodes on plant roots to convert the nitrogen.
    C Chloroplasts in the plant cells convert the nitrogen.
    D Fungi living in the plant capture the nitrogen before the plant can use it.

62. Deer, birds, and many small animals inhabit _____.
    A the tropical rainforest
    B the desert
    C the deciduous forest
    D the taiga

63. A glass of water is placed in a sunny window and left for the day. The next day, there is less water in the glass. The ***best*** explanation for what happened to the water is _____.



    A someone poured the water out
    B heat from the sun caused the water to evaporate
    C the water boiled in the window and steam escaped
    D the water in the glass froze

64. Which layer in the atmosphere helps to protect us against harmful UV radiation?
    A asthenosphere
    B ozone layer
    C lithosphere
    D corona

65. What is the speed of a ball that travels 75 meters in 10 seconds? (speed = distance/time)
    A 0.13 meters per second
    B 85 meters per second
    C 7.5 meters per second
    D 750 meters per second

66. The measure of gravitational force on an object is called _____.
    A mass
    B weight
    C gravity
    D resistance

67. A group of students decided to conduct an experiment. They filled a large bowl with hot water. In the bowl they put three spoons: a wooden spoon, a plastic spoon, and a metal spoon. After two minutes, they observed the difference in the temperatures of the handles of the spoons. The chart below shows their observations.

Spoon	Observation
Wooden spoon	The temperature of the handle did not change.
Metal spoon	The handle heated up quickly.
Plastic spoon	The handle became warm but not as quickly as the metal spoon.

    Based on the information in the table you can infer _____.
    A the wooden spoon is the best conductor of heat
    B the metal spoon is the best conductor of heat
    C the plastic spoon is the best conductor of heat
    D the plastic spoon and the wooden spoon are equal conductors of heat

68. The loss of habitat for forest animals can be prevented by _____.
    A recycling wood products
    B encouraging the building of shopping malls
    C using more public transportation
    D building more dams for hydroelectric power

69. The states of matter seen in the picture are _____.

    A solid and liquid
    B liquid and gas
    C solid and gas
    D solid, liquid, and gas

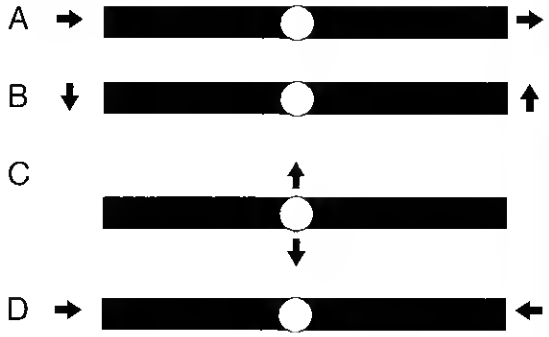
70. Hampton burned his hand when he tried to move this pot from the stove. He was burned because the metal handle is _____.

    A an insulator
    B a conductor
    C an evaporator
    D a condenser

71. Matter can undergo changes. When water boils, it changes _____.
    A from a liquid to a solid
    B from a gas to a liquid
    C from a liquid to a gas
    D from a solid to a liquid

72. Hawks and other predators at the top of a food chain are the most severely affected by pesticides in the environment. Which statement is the ***best*** explanation for this fact?
    A Hawks' bodies are sensitive to chemicals.
    B Hawks have a rapid reproduction rate.
    C The food they eat contains concentrated amounts of pesticides.
    D Hawks cannot store pesticides in their body tissues.

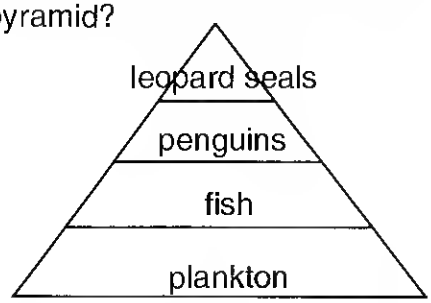
73. A steel pole is placed on a pivot, which lies in the middle of the pole. Two forces act on the pole. Each force has the same size. In which example would the pole turn?



74. A man bicycles 10 km to work in 0.5 hour. What is his speed? (speed = distance/time)
    A 20 km/hr
    B 40 km/hr
    C 5 km/hr
    D 50 km/hr

75. What type of clouds forms at very high altitudes out of ice crystals and has a wispy, featherlike shape?
    A stratus
    B cumulus
    C cirrus
    D cumulonimbus

76. What happens in an energy pyramid as you go from the base to the top of the pyramid?



    A Animals die faster.
    B Energy is stored as a heat source.
    C More and more food and energy are available.
    D Less and less food and energy are available.

77. _____ is the amount of water vapor in the air.
    A Evaporation
    B Air pressure
    C Humidity
    D Condensation

78. Moving objects, including wind, in both hemispheres will curve in the opposite direction of the spinning Earth. This is ***most likely*** caused by _____.
    A the Coriolis effect
    B the trade winds
    C the prevailing westerlies
    D the horse latitudes

79. What is one of the ***most interesting*** features of a deciduous forest?
    A the variety of wildlife
    B the ability to remain dormant
    C the process of photosynthesis
    D the way it changes seasons

80. Your body uses the force of_____ to move forward.
    A force
    B inertia
    C gravity
    D friction

81. What type of heat flow is illustrated by the warmth of an oven heating a kitchen?
    A radiation
    B convection
    C conduction
    D conversion

82. Which of the following is a learned behavior?
    A a cat sleeping each day for 3 hours
    B a plant growing in the sunlight
    C a bee courting the queen bee
    D a lion jumping through a flaming hoop

83. What brings warm ocean currents from the equator north through the Caribbean Sea and up the east coast of the United Sates?
    A the jet stream
    B a sea breeze
    C the Gulf Stream
    D a mountain breeze

84. Which global air mass is hot and extremely humid?
    A Maritime Polar
    B Maritime Equatorial
    C Continental Tropical
    D Continental Antarctic

85. Synoptic weather maps are used ***most often*** to help meteorologists do what?
    A forecast the weather
    B calculate rainfall totals
    C predict earthquakes
    D track a hurricane

86. Organisms that break down dead wood and other dead organisms into carbon dioxide and ammonia are called _____.
    A producers
    B consumers
    C decomposers
    D fertilizers

87. The mistletoe plant grows on the trunk or branches of trees. Mistletoe is a good example of _____.
    A mutualism
    B evolution
    C ecology
    D parasitism

88. When air masses with different conditions meet, they do not mix together. They form a narrow boundary between them called a _____.
    A maritime
    B front
    C stationary
    D cumulus

89. Why can you slide across a kitchen floor in your socks, but ***not*** across a carpeted room?
    A The smooth kitchen floor offers more inertia than a carpeted floor.
    B The smooth kitchen floor offers less friction than a carpeted floor.
    C The smooth kitchen floor is cleaner than the carpeted floor.
    D The smooth kitchen floor offers more friction than a carpeted floor.

90. A large woman and a small woman bungee jump off the same cliff in Hawaii at the same time. Who will fall faster?
    A They will fall at the same rate.
    B large woman
    C small woman
    D the bungee cord

91. A child on roller blades travels 2 km north in 0.5 hour. What is her velocity? (velocity = speed [distance/time] + direction travelled)
    A 4 km/hr
    B 1 km/hr, north
    C 4 km/hr, north
    D 1 km/hr

92. Which climate zone lies in the middle latitudes where summers are warm and winters are cool or cold, and precipitation may be plentiful?
    A ocean zone
    B tropical zone
    C polar zone
    D temperate zone

ANSWER SHEET
EOG 5th Grade SCIENCE — DIAGNOSTIC TEST

Name_____

INSTRUCTIONS:

1. Fill in your name at the top of this page.
2. Tear out this page.
3. Answer each question and fill in the appropriate bubbles (A, B, C, or D) on this sheet.
4. Once your teacher grades your answers, circle the numbers of your missed questions on the "Diagnostic Test Breakdown" on the back of this page.
5. By looking at the circled numbers on the breakdown sheet, you will be able to tell which areas (chapters) you need to study.

1. Ⓐ Ⓑ Ⓒ Ⓓ	24. Ⓐ Ⓑ Ⓒ Ⓓ	47. Ⓐ Ⓑ Ⓒ Ⓓ	70. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ	25. Ⓐ Ⓑ Ⓒ Ⓓ	48. Ⓐ Ⓑ Ⓒ Ⓓ	71. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ	26. Ⓐ Ⓑ Ⓒ Ⓓ	49. Ⓐ Ⓑ Ⓒ Ⓓ	72. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ	27. Ⓐ Ⓑ Ⓒ Ⓓ	50. Ⓐ Ⓑ Ⓒ Ⓓ	73. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ	28. Ⓐ Ⓑ Ⓒ Ⓓ	51. Ⓐ Ⓑ Ⓒ Ⓓ	74. Ⓐ Ⓑ Ⓒ Ⓓ
6. Ⓐ Ⓑ Ⓒ Ⓓ	29. Ⓐ Ⓑ Ⓒ Ⓓ	52. Ⓐ Ⓑ Ⓒ Ⓓ	75. Ⓐ Ⓑ Ⓒ Ⓓ
7. Ⓐ Ⓑ Ⓒ Ⓓ	30. Ⓐ Ⓑ Ⓒ Ⓓ	53. Ⓐ Ⓑ Ⓒ Ⓓ	76. Ⓐ Ⓑ Ⓒ Ⓓ
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9. Ⓐ Ⓑ Ⓒ Ⓓ	32. Ⓐ Ⓑ Ⓒ Ⓓ	55. Ⓐ Ⓑ Ⓒ Ⓓ	78. Ⓐ Ⓑ Ⓒ Ⓓ
10. Ⓐ Ⓑ Ⓒ Ⓓ	33. Ⓐ Ⓑ Ⓒ Ⓓ	56. Ⓐ Ⓑ Ⓒ Ⓓ	79. Ⓐ Ⓑ Ⓒ Ⓓ
11. Ⓐ Ⓑ Ⓒ Ⓓ	34. Ⓐ Ⓑ Ⓒ Ⓓ	57. Ⓐ Ⓑ Ⓒ Ⓓ	80. Ⓐ Ⓑ Ⓒ Ⓓ
12. Ⓐ Ⓑ Ⓒ Ⓓ	35. Ⓐ Ⓑ Ⓒ Ⓓ	58. Ⓐ Ⓑ Ⓒ Ⓓ	81. Ⓐ Ⓑ Ⓒ Ⓓ
13. Ⓐ Ⓑ Ⓒ Ⓓ	36. Ⓐ Ⓑ Ⓒ Ⓓ	59. Ⓐ Ⓑ Ⓒ Ⓓ	82. Ⓐ Ⓑ Ⓒ Ⓓ
14. Ⓐ Ⓑ Ⓒ Ⓓ	37. Ⓐ Ⓑ Ⓒ Ⓓ	60. Ⓐ Ⓑ Ⓒ Ⓓ	83. Ⓐ Ⓑ Ⓒ Ⓓ
15. Ⓐ Ⓑ Ⓒ Ⓓ	38. Ⓐ Ⓑ Ⓒ Ⓓ	61. Ⓐ Ⓑ Ⓒ Ⓓ	84. Ⓐ Ⓑ Ⓒ Ⓓ
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17. Ⓐ Ⓑ Ⓒ Ⓓ	40. Ⓐ Ⓑ Ⓒ Ⓓ	63. Ⓐ Ⓑ Ⓒ Ⓓ	86. Ⓐ Ⓑ Ⓒ Ⓓ
18. Ⓐ Ⓑ Ⓒ Ⓓ	41. Ⓐ Ⓑ Ⓒ Ⓓ	64. Ⓐ Ⓑ Ⓒ Ⓓ	87. Ⓐ Ⓑ Ⓒ Ⓓ
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20. Ⓐ Ⓑ Ⓒ Ⓓ	43. Ⓐ Ⓑ Ⓒ Ⓓ	66. Ⓐ Ⓑ Ⓒ Ⓓ	89. Ⓐ Ⓑ Ⓒ Ⓓ
21. Ⓐ Ⓑ Ⓒ Ⓓ	44. Ⓐ Ⓑ Ⓒ Ⓓ	67. Ⓐ Ⓑ Ⓒ Ⓓ	90. Ⓐ Ⓑ Ⓒ Ⓓ
22. Ⓐ Ⓑ Ⓒ Ⓓ	45. Ⓐ Ⓑ Ⓒ Ⓓ	68. Ⓐ Ⓑ Ⓒ Ⓓ	91. Ⓐ Ⓑ Ⓒ Ⓓ
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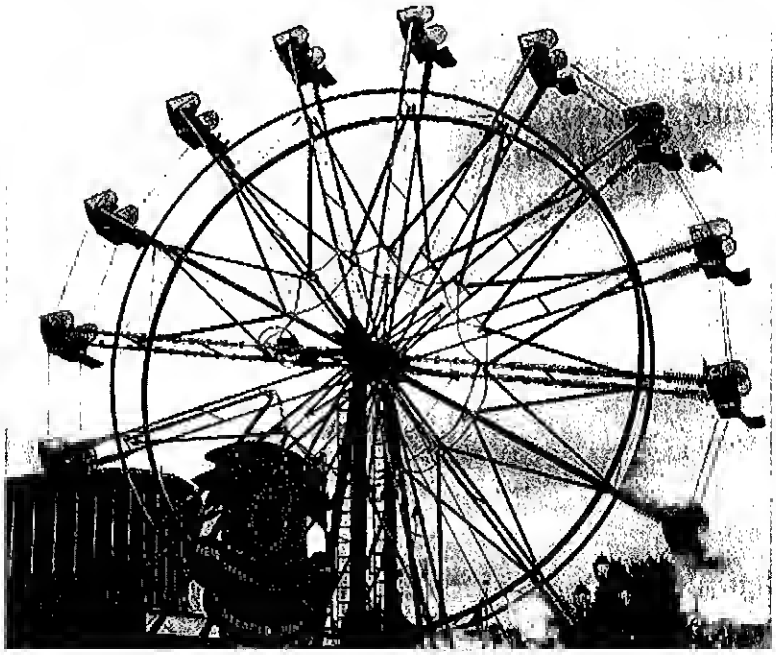
Diagnostic Test Breakdown

Chapters	Related Problems
1—Scientific Inquiry	1, 2, 3, 4, 8, 10, 23, 42
2—Understanding Force and Motion	5, 11, 18, 19, 32, 34, 39, 40, 41, 48, 65, 66, 73, 74, 80, 89, 90, 91
3—Matter and Energy	15, 31, 36, 38, 43, 56, 67, 69, 70, 71, 81
4—Understanding Weather and Climate	7, 37, 44, 45, 46, 47, 50, 57, 64, 75, 77, 78, 83, 84, 85, 88, 92
5—Living Organisms	6, 9, 13, 16, 17, 22, 25, 26, 27, 28, 29, 30, 63, 82
6—Populations and Ecosystems	12, 14, 20, 21, 24, 33, 35, 49, 51, 52, 53, 54, 55, 58, 59, 60, 61, 62, 68, 72, 76, 79, 86, 87

CHAPTER 1
SCIENTIFIC INQUIRY

PROCESS SKILLS

Welcome to the North Carolina State Fair in Raleigh! Stroll the grounds, eat, drink, play games, and help judge a pig contest. While you are having fun, you will also sharpen your **process skills**. Process skills are tools you use to explore the world. They help you organize information and make sense of your surroundings. Most of the time, you are not even aware you are using them. Scientists, however, pay special attention to these skills. There are six process skills you will sharpen as you learn to think like a scientist at the State Fair.



The North Carolina State Fair in Raleigh

The Six Process Skills

1. Observe
2. Classify
3. Measure
4. Communicate
5. Infer
6. Predict

Observe

You enter the fairgrounds and immediately you notice there are a lot of people. People are huddled around a booth to buy tickets for the rides. People are crowded around a lemonade stand. People are waiting in line to use the water fountain and the bathroom.

But you are too excited to stand in a line! You keep walking and soon you observe a **change** in the number of people. Change is a difference in some **quality** (a general property) or **quantity** you observe. You do not usually stop to measure a change of this nature. You just note whether or not you like the change. Is it better or worse than before? You decide you like the change of having fewer people around. It allows you to step up to the very next lemonade stand and get an ice cold drink right away.

There is a lot of waiting in line at the State Fair, so sometimes it is better to wait for a change in the number of people in line.

The lemonade at this stand was very sour.

You take your first sip of lemonade and make a face. This lemonade tastes sour! Your sense of taste allows you to make this observation. Taste is one of your five senses that allows you to take in information about the outside world. **Your five senses include seeing, hearing, tasting, touching, and smelling**. These senses help you make **observations** (**qualitative data**-information collected and communicated in words) about your surroundings.

For example, you use your sense of **sight** to observe the colors around you. You see the bright yellow, orange, red, blue, and green colors of a clown's costume. Your sense of sight also helps direct you to all the fun. By reading signs, you can tell where to find the rides, contests, and other attractions.

Your sense of sight allows you to observe the colors of a clown's costume.

Your sense of **smell** draws you to one of the main attractions at the fair—the animals. You follow your nose into a giant barn where you see pigs, sheep, and goats. You observe that the animals smell really bad. This is because animals do not take baths every day like people do. Just think, if you did not have to take a bath or shower, you could smell this bad too!!

Some of the animals at the fair smell really bad.

Cotton candy is sticky which you observe with your sense of touch.

You leave the barn with your sense of smell still guiding you. This time it is to your favorite food—cotton candy! You make your purchase and dig into the tasty treat. Your sense of **touch** allows you to observe that cotton candy is fluffy and very sticky. By the time you are finished, your hands are a sticky mess. You decide to find a bathroom so you can clean your hands.

Classify

When you emerge from the bathroom, music and loud voices draw your attention. Your sense of **hearing** guides you to the next point of interest—the games. There are so many different games to choose from! How do you decide which games to play? To help narrow the selection, you decide to sort the games. To sort means to separate objects by some feature. Oftentimes you will **sort** objects by size, color, texture, weight, and so on. In this case, however, you will sort the games by the skill required for each one.

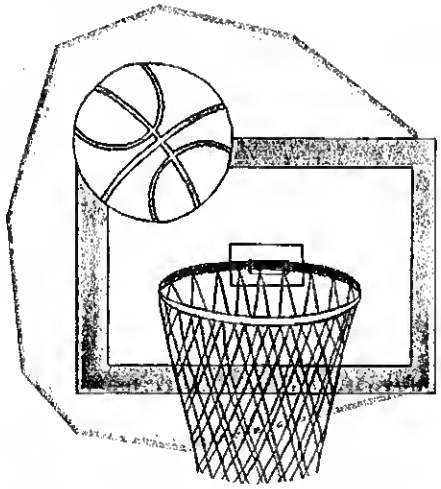
Each game has a required skill. By mental sorting, you can choose which one will be easiest for you.

For example, most games involve throwing an object at something. Are you good at throwing, or are you better at shooting a moving target? The following tables sort the games into two groups based on the skills required for each one.

Shooting Games	Objective
Quack Master	Shoot at swimming ducks.
Bull's Eye	Shoot at the center of a target.

Throwing Games	Objective
Clown Around	Throw a small ball into a clown's mouth.
Magic Hoops	Make a basket with a basketball.
Pop Eye	Throw darts at eyeball-painted balloons.
Ring Your Neck	Toss a ring over a bottle neck.

After some thought, you decide you have good aim with a basketball. Maybe this is the skill that you practice the most at home. You have three chances to make a basket, and you succeed on the third try! You win a giant stuffed monkey. However, after only a few minutes of walking with your giant prize, you get tired of carrying it. You decide the next time you come to the fair, you will save the games for last.



You choose a game that requires good aim.

PRACTICE

1. Name two changes you have noticed at school.

   1. _____

   2. _____

2. Name two changes you have noticed at home.

   1. _____

   2. _____

3. Which senses could you use to observe a pony? How would you use them?

4. Which sense would you use to observe the colors of a flower arrangement?

5. Which sense would you use to judge a baking contest?

6. Which sense would you use to judge a singing contest?

7. Which sense would you use to find a popcorn vendor?

8. Sort the following chores into two groups—those that require water and those that do not.

sweeping	mopping	dishes
dusting	laundry	vacuuming
cutting the grass	bath	

Water	No Water

9. Name three changes you observe daily. Think of a way you could record each change.

   1. _____

   2. _____

   3. _____

10. Which of your five senses tells you that dinner is in the oven?

    _____

11. Arrange your school subjects in order from easiest (1) to hardest (6).

    1. _____

    2. _____

    3. _____

    4. _____

    5. _____

    6. _____

12. Name two ways you could sort your clothes.

    1. _____

    2. _____

Measuring

You are thirsty again so you decide to get another lemonade. You stop at a different stand this time. You observe that you get a larger drink, yet it costs the same as the last one. You decide this new lemonade stand is a better bargain, so you try to remember its location for next time. However, as you walk away sipping your drink, you are surprised to find that it is already gone! How did you manage to consume such a large lemonade in so short a time? Maybe it was not so large after all. Let us examine the cup.

It is hard to estimate volume by looking at some containers.

Look at the cup in the figure. It seems large because it is tall. The cup is actually very narrow at the base. It is wide only where it flares out at the top. What is more, the bottom of the cup is hollowed out, so it holds no liquid at all. In addition, the sides of the cup are made of thick plastic, leaving even less room for the lemonade.

You have made the common mistake of estimating the **volume** of a liquid by the appearance of its container. The volume of a liquid is the amount of space that liquid takes up. As you can see, it is very difficult to judge volume by the size of its container. A scientist would not be content with estimating differences in size. A scientist would take this observation a step further and actually **measure** the difference. When you measure, you are observing the **quantity** of an object. A quantity is exact information about a quality you observe. **Quantitative data** is exact information about a quality you observe. Quantitative data is reported in *numbers* rather than in *words*. For example, you could tell someone that the ocean is warm, but they would find it more helpful to know the exact temperature of the water.

Two Systems of Measure

There are two ways to measure. The most familiar way comes from the United Kingdom. It is called the **Imperial System**. This is the system commonly used in the United States. It uses inches, pounds, and gallons. The other, the metric system, is used by most foreign countries and by scientists. For this reason, we will explore the metric system in detail.

At the heart of both systems are **base units**. Base units are standard measurements that describe the exact nature of some quality. For example, the base unit of length in the Imperial System is the **yard**. The base unit of length in the **metric system** is the **meter**. Everyone everywhere in the world agrees on the base units of the metric system. In Japan, the meter is the exact same length that it is in the United States.

The tables below show the quantities, base units, and symbols of both systems.

Imperial System

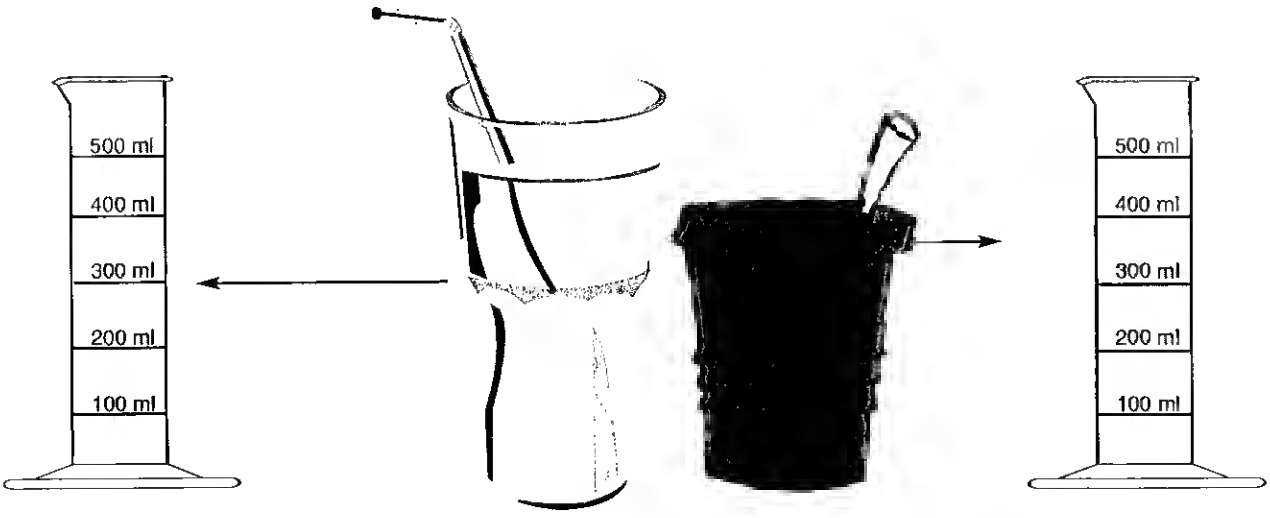
Quantity	Base Unit	Symbol
length	inch/foot/yard	in./ft/yd
mass/weight	pound	lb
time	minute/second	min/sec
volume	gallon/quart	gal/qt
temperature	degrees Fahrenheit	°F

Metric System

Quantity	Base Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
volume	liter	L
temperature	Kelvin	K

Volume

In the metric system, the base unit for volume is the **liter**. A water bottle holds about 1 liter of water. The liter is divided into 1,000 smaller, equal units called **milliliters**. There are 1,000 milliliters in 1 liter. Smaller volumes, like the amount of lemonade in the cup, are measured in milliliters using a **graduated cylinder**. A graduated cylinder is a piece of laboratory glassware with a printed scale on the side. To measure the volume of lemonade in your tall, skinny cup, you would pour it from the cup into a graduated cylinder and read the volume using the scale printed on the side. Because liquids change shape easily, it is hard to compare volume by estimating alone. To avoid being taken in the future, you could ask what volume a cup holds.



Sometimes it pays to measure the volume of a liquid.

PRACTICE

1. What is the volume of lemonade in the tall, skinny cup?

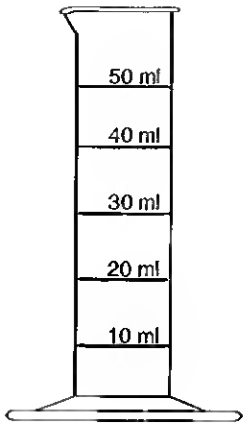
_____

2. What is the volume of lemonade in the short, fat cup?

_____

3. What is the volume of liquid in the graduated cylinder?

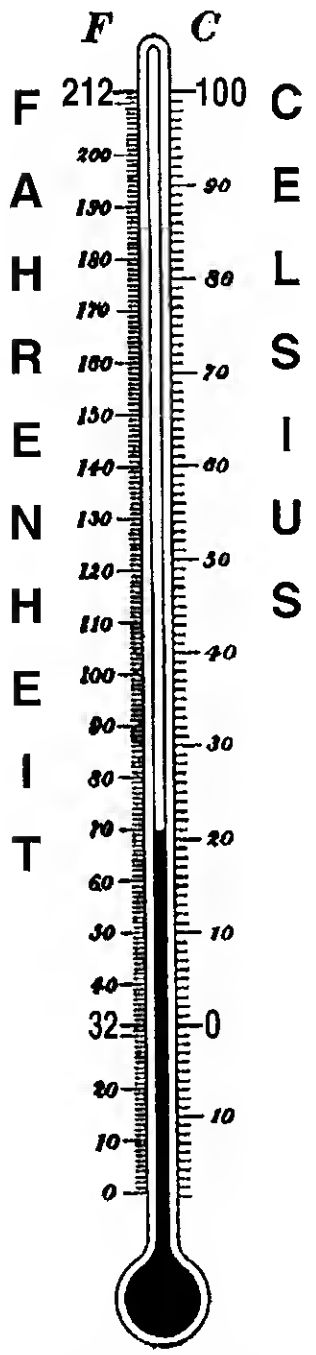
_____



Temperature

Temperature is a measure of the warmth of a place or an object. In the metric system, the official temperature scale is the **Kelvin** scale. However, it is used by only a few scientists who usually measure much higher or lower temperatures than those we normally encounter. There are two other scales by which people measure temperature. Let us review these commonly used temperature scales.

These two men cannot agree about the temperature.



This thermometer measures degrees in both Fahrenheit and Celsius. Celsius is sometimes called Centigrade.

On the **Celsius** scale, water boils at 100°C and freezes at 0°C. On the **Fahrenheit** scale, water boils at 212°F and freezes at 32°F. The **thermometer** shows the Celsius and Fahrenheit scales side-by-side. A thermometer is a device that measures temperature in units called **degrees**. Many scientists use the Celsius scale to describe temperature. However, in the United States, non-scientists use the Fahrenheit system to talk about the weather.

As you stroll the grounds, you encounter two men arguing about the temperature. One says the temperature this year is the warmest it has ever been. The other asserts that the State Fair of 2007 was warmer.

You decide to step in and help these men settle their differences. You passed a booth earlier that had some back issues of the Farmer's Almanac. You decide to look up the **temperature** for October over the last six years to see which year was the warmest.

You notice that the weather data in the Almanac is listed in degrees Fahrenheit. You record the data in the table below. You discover from this data that the second man was right. The warmest year was 2007, with a temperature of 80°F.

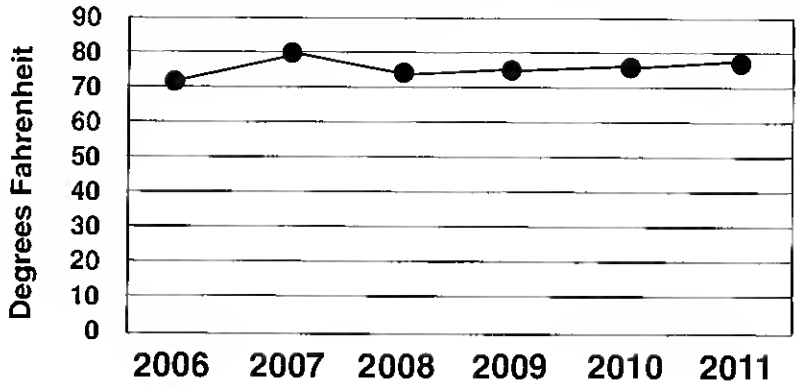
PRACTICE

1. Use the thermometer to convert degrees Fahrenheit to degrees Celsius. Use your results to fill in the rest of the table.

Year	Temperature (Fahrenheit)	Temperature (Celsius)
2006	73°F	
2007	80°F	
2008	75°F	
2009	77°F	
2010	78°F	
2011	79°F	

You decide to **graph** the results so the men will have a clear picture **and** no further reason to argue. Graphs are **picture versions** of data that are easy to read. The scale at the bottom of the graph, the x-axis, shows the year. The scale on the side, the y-axis, shows the temperature range.

Historical Temperature (˚F) at State Fair in Raleigh

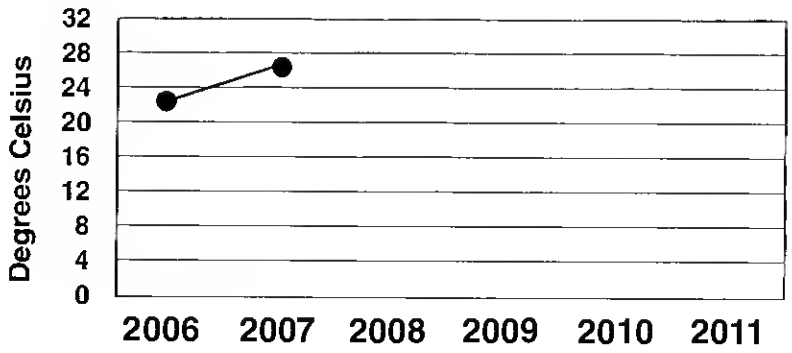


PRACTICE

1. With the exception of the year 2007, what trend can you spot in the data?

2. Using your converted Celsius temperatures from the table on the previous page, draw a line graph that represents the data. To draw this, take a ruler and stand it straight up over the year you are plotting (parallel to the y-axis). Read across to the y-axis and find the correct temperature. Where the year and the temperature intersect, draw a dot. Do the same thing for the temperatures of the other years. When you are finished, connect the dots until you have a line covering all six years.

Historical Temperature (˚C) at State Fair in Raleigh



3. Following the trend over the last four years, predict the temperature for the next four years:

Year	Temperature (Fahrenheit)	Temperature (Celsius)
2012		
2013		
2014		
2015		

Mass

It is time for the Blue Ribbon Pig Competition. You have been asked to keep track of the scores for each contestant. You will collect data in a table and then graph the results.

At the State Fair, mass is important when judging the pig competition.

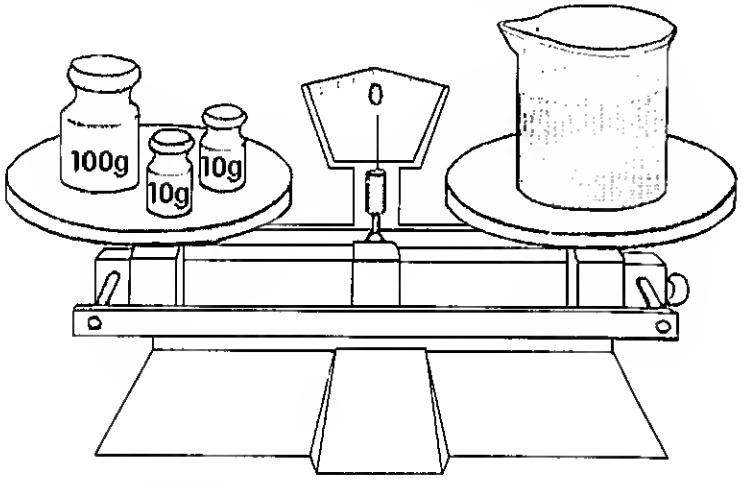
The judges first determine the mass of each animal. **Mass** is the amount of matter in each pig. The base unit for mass in the metric system is called the **kilogram**. Like the meter, the kilogram is divided into smaller, equal units. They are called **grams**. There are 1,000 grams in one kilogram.

Mass and weight are often thought to be the same thing. However, weight is different from mass because it is affected by **gravity**. Gravity is a force on Earth that pulls objects toward the Earth. In outer space, where there is no gravity, objects have no weight. These pigs would be "weightless" in outer space. Mass, on the other hand, is always the same no matter where an object is located. We will use the more scientific term, mass, in this book.

Scientists use a **balance** to measure mass. A balance has weights with numbers on them. The numbers tell how heavy the weights are. If the object is heavier than the weights, the arm of the balance will tilt down. If you keep adding weights, both arms will balance out. The mass of the object is the sum of the weights.

For example, the mass of this beaker of sand is found by adding the weights.

100 grams
10 grams
+ 10 grams
---
120 grams



The beaker of sand has a mass of **120 grams**.

The first pig is lifted onto a large balance. The following weights are used to balance it:

3-10 kg weights = 30 kg
2-1 kg weights = 2 kg

30 kg + 2 kg = 32 kg

The first pig's mass is 32 kg.

PRACTICE

1. What is the mass of the second pig?

The second pig is lifted onto the balance. The following weights are used:
3-10 kg weights
1-5 kg weight
1-1 kg weight

2. What is the mass of the third pig?

The third pig is lifted onto the balance. The following weights are used:
3-10 kg weights

3. What is the mass of the fourth pig?

The fourth pig is lifted onto the balance. The following weights are used:
3-10 kg weights
4-1 kg weights

Put the pig mass data from above into the table below.

Pig	Mass
1	32 kg
2	
3	
4	

4. Which pig has the greatest mass?

5. Which has more mass, 1 gram or 1 kilogram?

6. An object is balanced using 2-100 gram weights and 1-5 gram weight. What is the mass of the object?

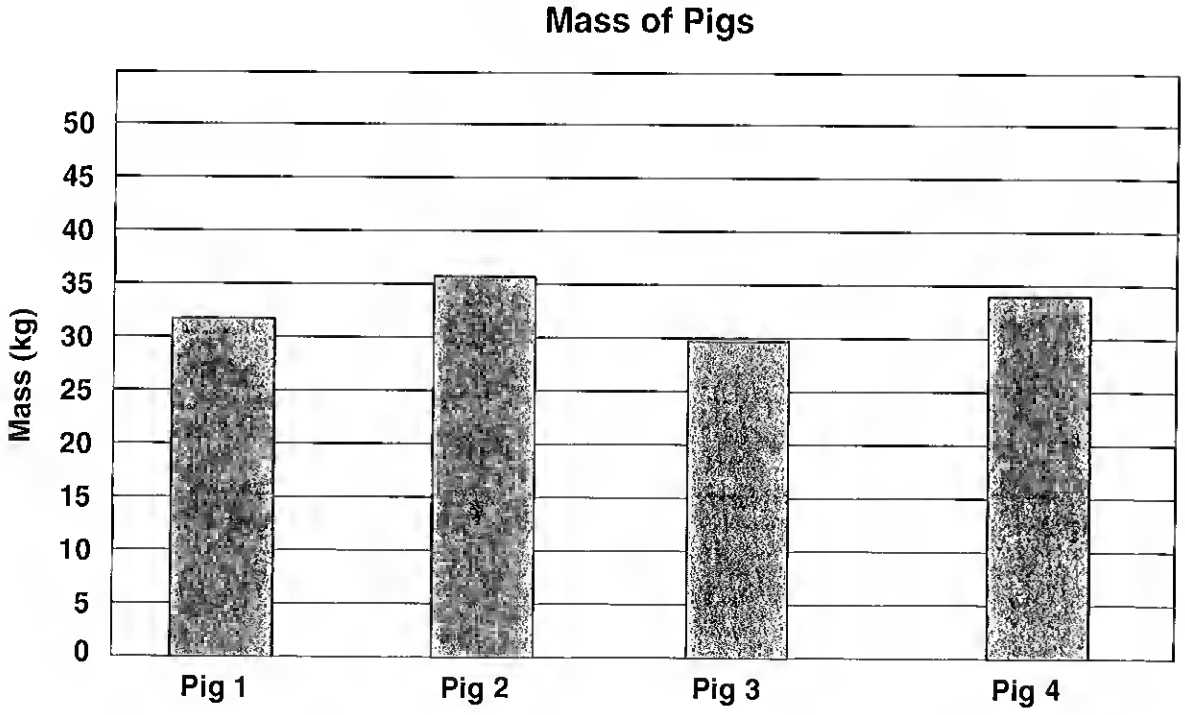
_____

7. An object is balanced using 3-10 gram weights and 2-1 gram weights. What is the mass of the object?

_____

The data from the table can be displayed in a bar graph. In the bar graph below, the x-axis shows which pig's mass is being displayed. The y-axis shows the mass range for this group of pigs. The individual bars show the mass of each individual pig. You can find the mass by starting at the top of each bar and following it across to the scale on the y-axis. By reading the number on the y-axis, you get the mass of each pig.

When data are shown side-by-side, as in a bar graph, it is easy to make comparisons. For example, the graph below clearly shows that pig #2 is heaviest.



PRACTICE

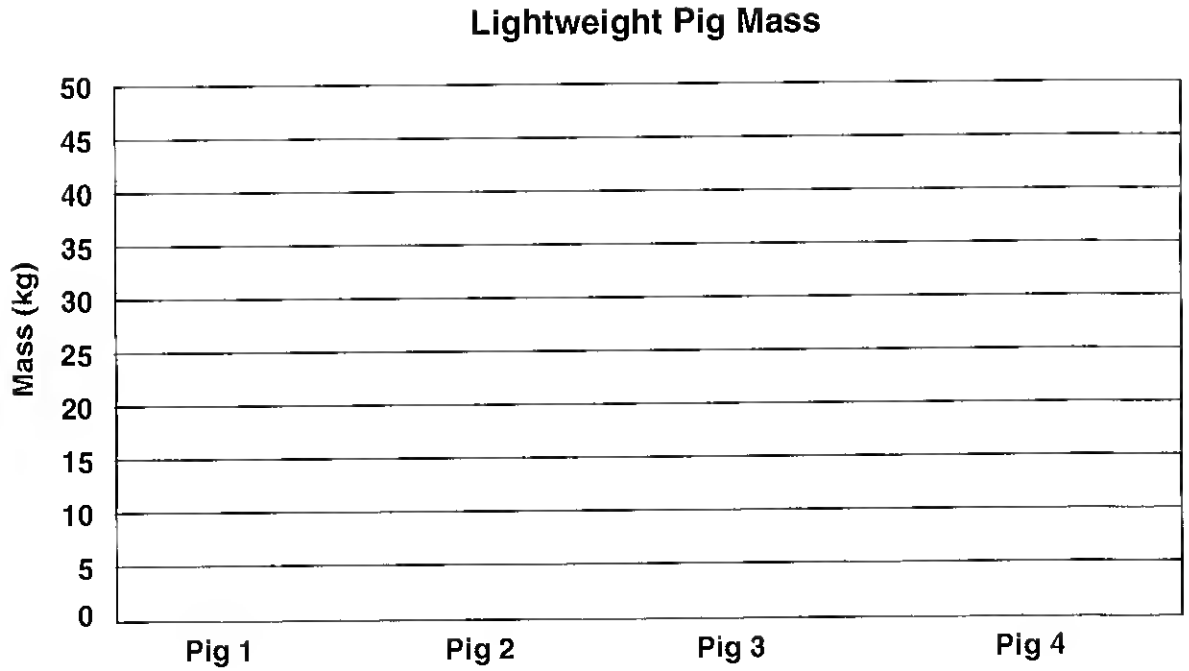
1. Which pig is the second heaviest?

_____

2. Which pig is the lightest?

3. The mass of a lightweight pig category is determined next. The data are shown below. Draw a bar graph using this data.

Pig	Mass
1	28 kg
2	24 kg
3	26 kg
4	30 kg



Length

Next, the judges measure the length of each animal. The base unit of length in the metric system is the **meter.** The meter is about the same length as the yard. To measure objects smaller than a meter, like the length of your thumb, the meter is divided into 100 small, equal units called **centimeters**. To measure longer distances, like the drive to school, the **kilometer** is used. There are 1,000 meters in one kilometer.

The judges use centimeters to measure the length of each pig. One judge holds a meter stick from the front leg to the hind leg of pig #1. She measures 53 cm, and you record this number in the table. Pig #2 measures 58 cm. Pig #3 measures 50 cm. Pig #4 measures 57 cm.

Put the data above into the table below.

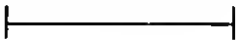
Pig	Length (cm)	Chest Width (cm)
1	53	22
2		
3		
4		

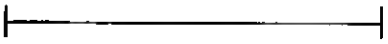
The judges next measure the chest width of each pig. A metric tape measure is pulled across each animal's chest from front leg to front leg. The judge calls out, "Pig #1-22 cm." You record this number in the table. Next she calls out, "Pig #2-25 cm. Pig #3-20 cm. Pig #4-21 cm."

Record this data in the table above.

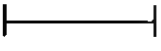
PRACTICE

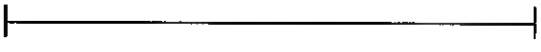
Measure the length, in centimeters, of the lines below.

1. _____cm 

2. _____cm 

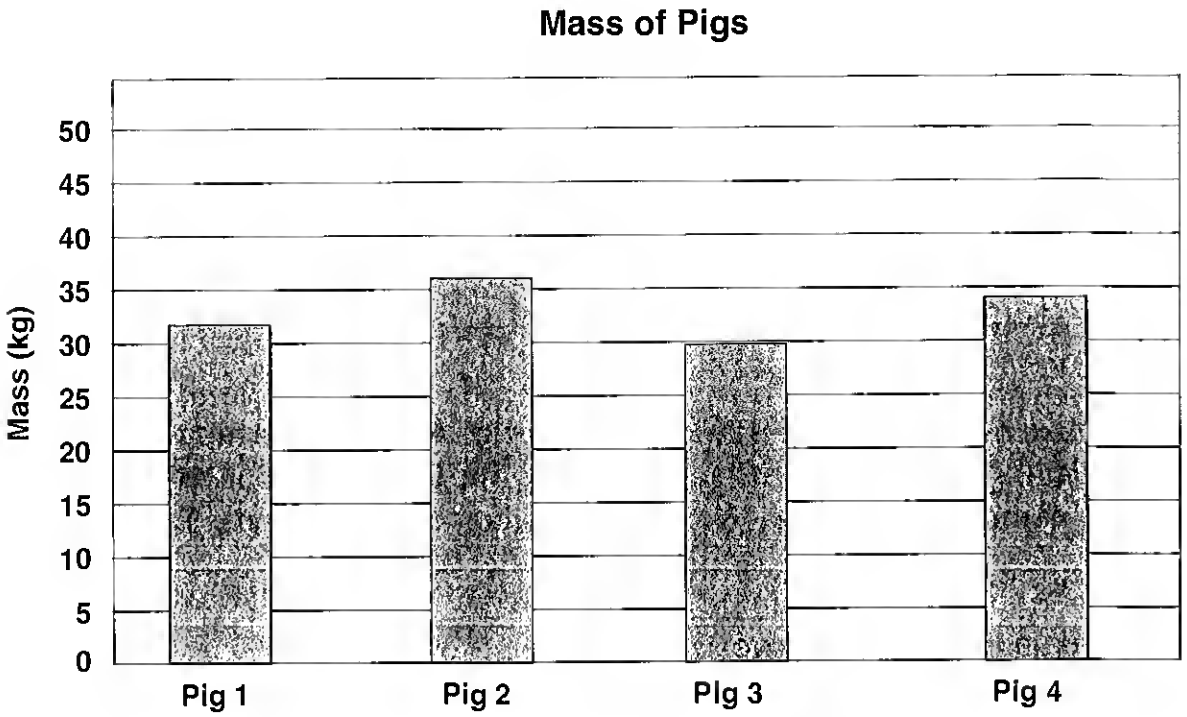
3. _____cm 

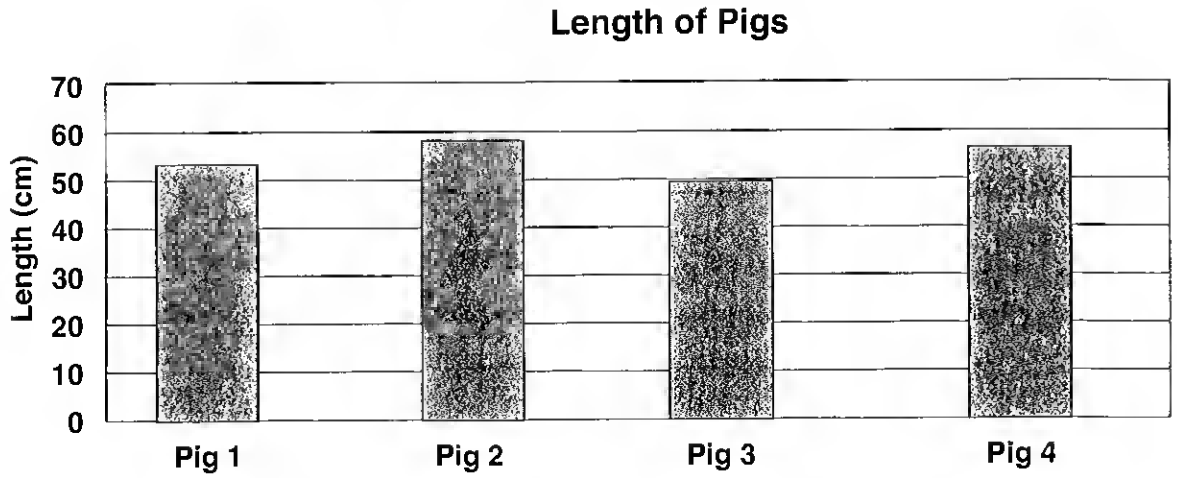
4. _____cm 

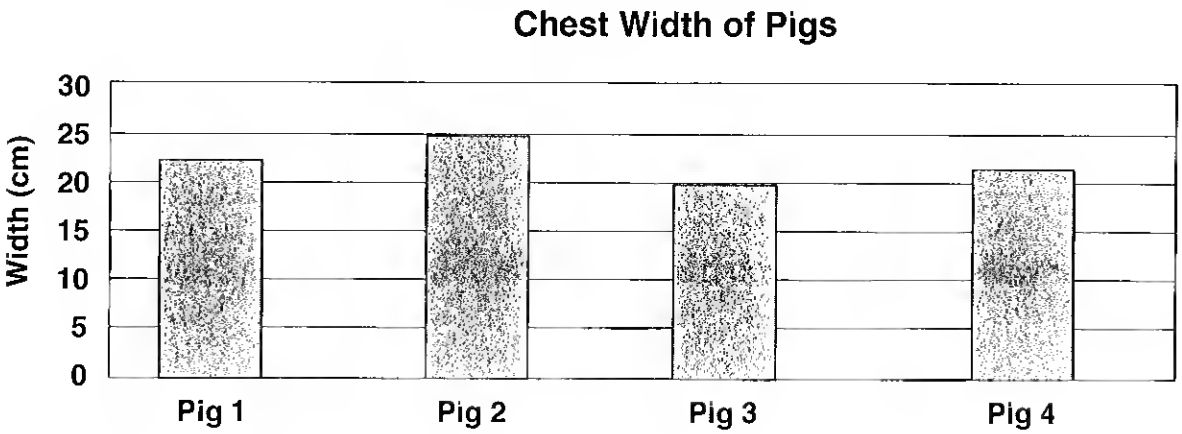
5. _____cm 

Communicate

You have taken a lot of measurements. Now it is time to **communicate** the data in a way that is easy for the judges to read. Scientists often summarize large amounts of data into graphs. To help the judges make quick comparisons, you summarized the data into the graphs below.







Infer

You make several observations as you look at the overall data. First of all, you notice that each measurement has to do with the animals' bulk. No one asks about a pig's color or whether it has a curly tail or straight tail. How heavy, how long, and how thick are the animals? These are the questions the judges need to have answered.

You might **infer** something about the animals based on this information. To infer means to reason something by matching your observations to what you already know. For example, you know that animals are slaughtered and sold for meat. You might infer that a heavier, longer, thicker animal will supply more pork chops, tenderloin, and bacon than a smaller animal. This means more profit for the pig farmer. You might also infer that a farmer will want to raise only the offspring of these larger animals.

You may have heard that the runt of the litter ends up smaller and sicklier than its siblings. For this reason a large, wide animal will probably be heartier and healthier than a small, skinny animal. Therefore, you might infer that large animals are a good investment because they are more likely to survive.

PRACTICE

1. You open a can of dog food while your dog watches and drools. What can you infer about your dog?

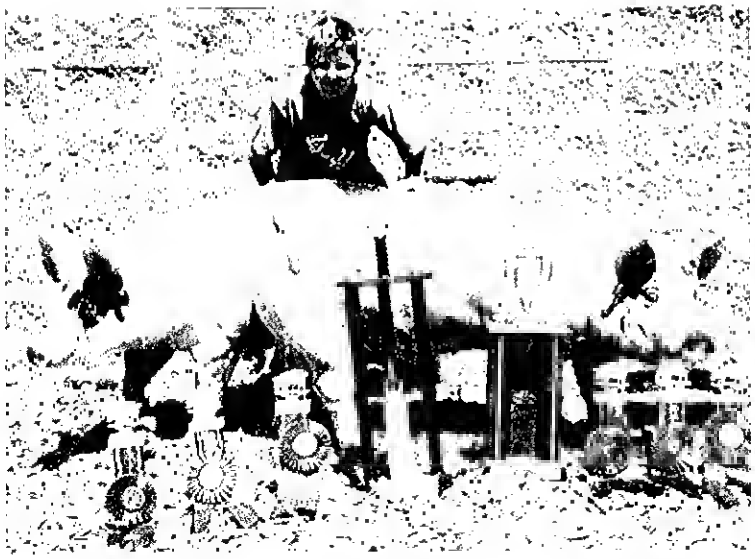
2. Imagine you are sitting in a playroom with no windows. Your friend comes in soaking wet. What can you infer about the outside?

3. Your brother walks into the house panting and sweating. What can you infer about his activity?

4. You come home for dinner to find a plate of cold food and everyone else already finished. What can you infer about the time?

Predict

Based on the data plus what you know about the way farm animals are valued, you can **predict** which animal will win the blue ribbon. To predict means to forecast something that will happen in the future. From a scientific viewpoint, both inferences and predictions involve data and prior knowledge. However, a prediction is different because it involves the telling of an event before it happens.



Which pig did you predict to win the blue ribbon?

The ribbons are awarded as follows:
1st place gets the blue ribbon.
2nd place gets the red ribbon.
3rd place gets the white ribbon.

Look at the data in the three graphs once more. You can see that Pig #2 had the highest marks in each measured category. You predict that Pig #2 will take home the blue ribbon.

PRACTICE

1. Predict which pig will receive the red ribbon.

   _____

2. Predict which pig will receive the white ribbon.

   _____

3. Suppose the blue-ribbon pig was later disqualified because it was fed illegal growth hormones. Which pig would now get the blue ribbon?

   _____

4. Which pig would get the red ribbon?

   _____

5. Which pig would get the white ribbon?

   _____

You use your process skills every day, whether or not you are aware of doing so. At the State Fair you practiced observing, classifying, measuring, communicating, inferring, and predicting. When you practice using these skills, you become more like a scientist. In the next section, you will get additional practice. You will also learn about two new process skills—making a hypothesis and defining variables.

THE SCIENTIFIC METHOD

Four years ago, a local high school student presented Farmer Griffin with some disturbing data. The data showed that chemicals from his corn fields were contaminating the local waterways. Farmer Griffin was troubled by this news. He decided to conduct a scientific experiment to see if he could grow his crops without chemicals. If he could still earn a living without using chemicals, he would change his way of farming.

There are seven steps in a scientific experiment. You will examine each step as you follow Farmer Griffin through his experiments with his corn crop.

Will I be successful in growing my crops without chemicals?

The 7 Steps of a Scientific Experiment

1. State the problem or question to be answered.
2. Make a hypothesis (guess) about the answer.
3. Identify and control variables.
4. Design the experiment.
5. Write a step-by-step procedure.
6. Collect and analyze data.
7. State the conclusion.

1. STATE THE PROBLEM OR QUESTION TO BE ANSWERED.

The first step in a scientific experiment is to ask a **good question**. Farmer Griffin's question is:

Question: Can I grow my corn crops without chemical fertilizers and weed controllers?

2. MAKE A HYPOTHESIS (GUESS) ABOUT THE ANSWER.

A **hypothesis** is a possible answer to a question. Farmer Griffin has experience growing corn, and he guesses his crops will not grow well without chemicals to kill weeds and bugs. A hypothesis is an educated guess based on knowledge or experience. He states his hypothesis as follows.

Hypothesis: The crop grown in the absence of chemicals will produce less corn than the crop grown in the presence of chemicals.

3. IDENTIFY AND CONTROL VARIABLES.

Next, Farmer Griffin must plan and conduct a **fair test**. A fair test is one in which all but one of the **variables** is kept the same. A variable is anything that can change the outcome of the experiment. In a good experiment, only one variable changes at a time.

Farmer Griffin must consider several variables in his experiment. For example, both crops must receive the same amount of water. If one crop is allowed to dry out it will not grow well. This poor growth could change the outcome of the experiment. The amount of water in the experiment will have to be "controlled." That is, the amount of the variable, water, that is given to each crop must be the same.

Another variable that can affect the outcome of the experiment is the amount of manure used in the soil. This too should be the same, or controlled, for both crops. The amount of minerals in the soil is a third variable. Each crop should be planted in soil that is equally rich in minerals.

In short, every factor affecting the growth of these two crops must be the same except for one. The only variable in this study that is allowed to change is the presence or absence of chemicals.

Variable: Presence or absence of chemicals.

4. DESIGN THE EXPERIMENT.

Next, Farmer Griffin must design his experiment and decide what materials he needs. He also decides on methods of weed and insect control for the crop receiving no chemicals. Otherwise, it won't stand a chance. He chooses a mechanical means of removing weeds and a natural plant extract to keep the insects away.

The materials he needs are:

Crop 1 (chemically treated)
- minerals (potassium-nitrogen-phosphorus mixture)
- manure
- corn
- water
- chemical weed killer
- chemical insect killer

Crop 2 (organic)
- minerals (potassium-nitrogen-phosphorus mixture)
- manure
- corn
- water
- weed machine
- plant extract

5. WRITE A STEP-BY-STEP PROCEDURE.

Now Farmer Griffin is ready to plan the steps of his experiment. They are as follows:

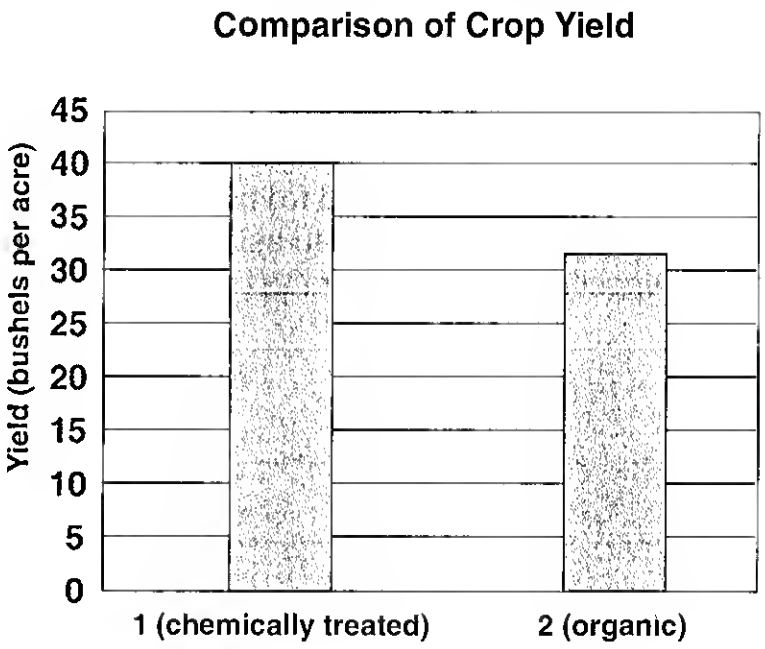
1. **Prepare soil by adding minerals and manure to both crop areas.**
2. **Plant corn.**
3. **Water crops every two days.**
4. **Remove weeds from Crop 2 once each week.**
5. **Spray chemicals on Crop 1 and natural plant extract on Crop 2 once each week.**
6. **Harvest crops.**

6. COLLECT AND ANALYZE DATA.

At the end of the growing season, Farmer Griffin recorded the following crop yields:

Crop	Yield (bushels per acre)
1 (chemically treated)	40
2 (organic)	32

Farmer Griffin graphed his results so he could compare them side by side.



7. STATE THE CONCLUSION.

Farmer Griffin found that he could grow 32 bushels of corn in a crop with no chemicals. This is a very important finding for him. However, as with most scientific experiments, it only led to more questions. How could he improve his yield? Should he add more manure? Should he adjust the amount of plant extract? These are just a few of the questions he asked himself as he moved into the next stage of innovation—technological design.

PRACTICE

1. List the 7 steps of the scientific experiment.

   1. _____

   2. _____

   3. _____

   4. _____

   5. _____

   6. _____

   7. _____

2. Terrance wants to know if eliminating fast food from his diet will help him lose weight. What is a good question for Terrance to ask that will help him set up a scientific experiment? Be specific. (You may want to include a time frame.)

   _____

   _____

   _____

   _____

3. Make a hypothesis for Terrance.

   _____

   _____

4. Terrance does not normally exercise. Should he begin an exercise program during his weight loss experiment? Why or why not?

   _____

   _____

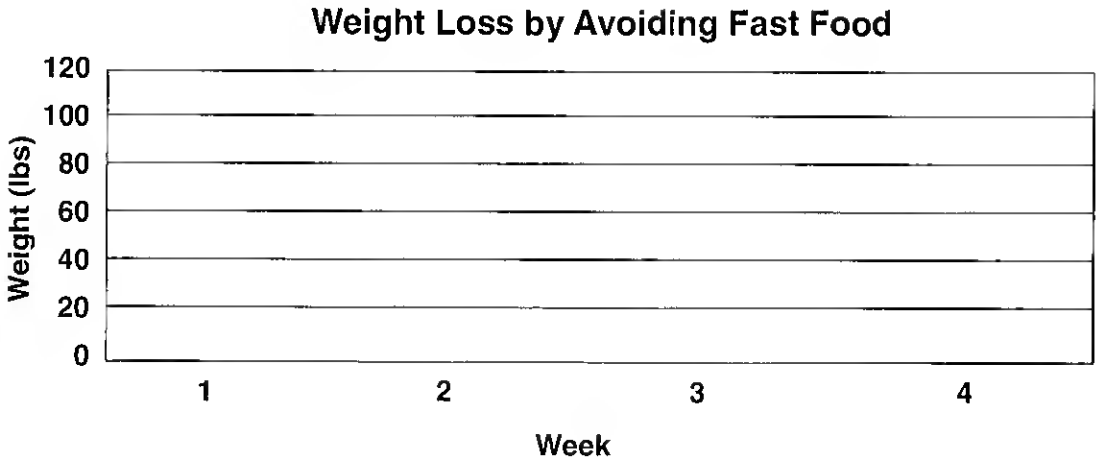
   _____

5. Write an experimental procedure for Terrance to follow during his diet.

6. Terrance collected the following data from his weight loss experiment:

Week	Weight (lbs)
1	120
2	118
3	116
4	112

Draw a line graph to represent this data.



7. What conclusion can you draw from Terrance's data?

8. What can you infer about the obesity problem in the United States?

9. Angela and Michael want to see who can fly a kite the highest. Name two variables they should control to make it a fair contest.

1.

2.

10. What conclusion can you draw from the following data?

Year	Average Monthly Expense for Groceries
2008	$340
2009	$360
2010	$380
2011	$400

TECHNOLOGICAL DESIGN

Technological design is similar to the scientific experiment in some ways. For example, they both identify problems, they both involve creative design, and they both evaluate results. However, the ultimate goal of each is somewhat different.

For example when Farmer Griffin started farming, he asked a question for the sake of learning something new. He had no particular plan for this knowledge. He simply wanted to know if he could grow his crops without chemicals. This kind of research is called **basic research**.

When he found that it was possible, he was faced with a problem which required a solution. Now he must take his new knowledge and apply it toward a solution. This kind of work is called **technological design**.

I will use technological design to solve my problem.

The 4 Steps of Technological Design

1. State the problem or need.
2. Design a solution or product.
3. Test the solution or product.
4. Evaluate the solution or product.

1. STATE THE PROBLEM.

Farmer Griffin decided he would like to grow his crops without chemicals. However, he must increase his yield if he is to make a profit. He decides he can live with a 5% loss

of crop and still meet all his financial needs. When identifying a problem, it is important to be as specific as possible. Being specific helps Farmer Griffin stay on track to meet his objective. His problem can be stated in the form of a question:

How can I decrease my crop loss from 20% to 5% without using chemicals?

2. DESIGN A SOLUTION.

Farmer Griffin has several ideas, so he writes them down on a sheet of paper. He could:

a. increase the manure content of the soil.

b. increase the mineral content of the soil.

c. increase the insect-killing plant extract.

Each of the above possibilities is a variable, and Farmer Griffin must change only one at a time. The other variables must be controlled or remain the same if he is to know which caused the observed changes in crop production.

Next, Farmer Griffin writes down his plan. First, he sections off a 4-acre plot of land. He decides that for three years he will dedicate this tract of land to testing the solutions. He labels this Crop 2. Crop 1 is reserved for maintaining the other two variables. In other words, Crop 1 is his control crop. His plan is as follows:

Year 1: Increase Manure Content	
Crop 1	0.7 LU/acre
Crop 2	1.4 LU/acre

Year 2: Increase Mineral Content	
Crop 1	1.0 kg/acre
Crop 2	2.0 kg/acre

Year 3: Increase Plant Extract	
Crop 1	100 g/acre
Crop 2	200 g/acre

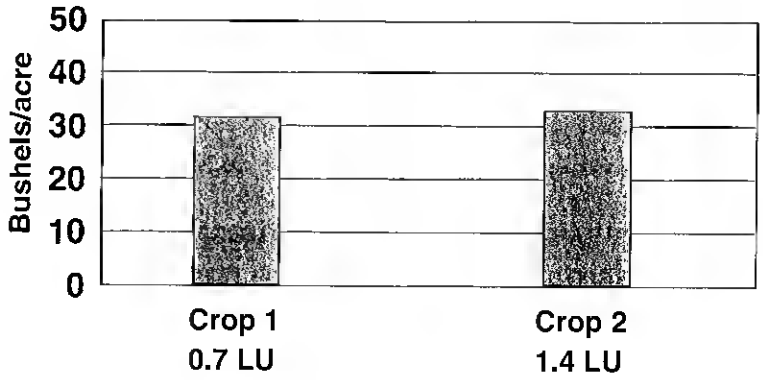
3. TEST THE SOLUTION.

The first year Farmer Griffin adjusts the amount of manure he uses to fertilize the soil. For Crop 1, he uses the usual amount of 0.7 livestock units (LU) per acre. For Crop 2, he doubles this amount to 1.4 LU. At harvest time, he observes a small but noticeable increase in yield.

Crop	Manure (LU)	Yield (bushels per acre)
1	0.7	32
2	1.4	33

He records his data in a graph.

Effect of Manure Concentration on Crop Yield

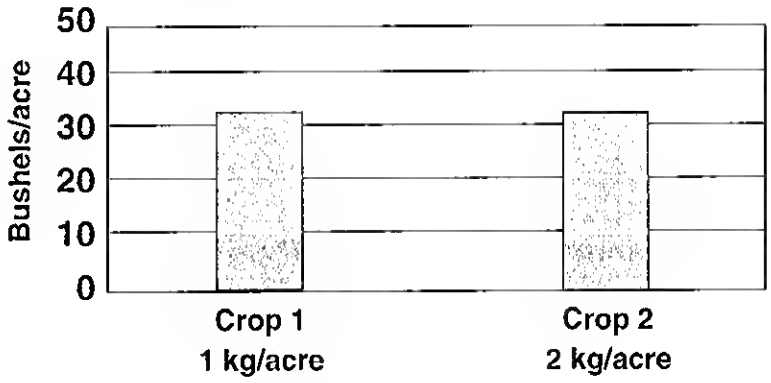


The second year he adjusts the amount of minerals in the soil. For Crop 1, he uses the usual amount of 1.0 kg/acre. For Crop 2 he doubles this amount to 2.0 kg/acre. At harvest time, he notices no increase in the yield of his crops. The increase in soil minerals did not help his crops at all.

Crop	Mineral Concentration (kg/acre)	Yield (bushels per acre)
1	1	32
2	2	32

He records his data in a graph.

Effect of Mineral Concentration on Crop Yield

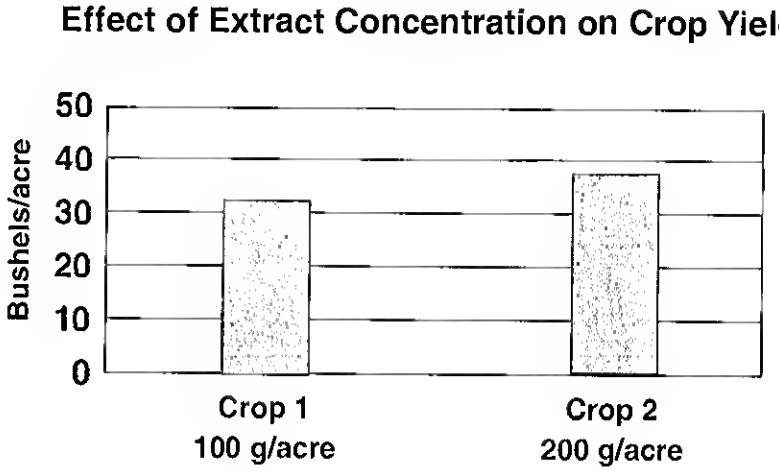


Farmer Griffin implements the last of the possible solutions in the third year. If an increase in plant extract does not improve his yield, he will have to go back to the conventional method of farming. However, he has reason to be hopeful about the plant extract. The reason he felt the harvest was so poor in the first two years was because many of the plants had been chewed away by insects. Therefore, he predicts that adding extra plant extract will protect his crops and allow them to grow better.

For Crop 1 he uses the usual amount of plant extract, 100 g/acre. For Crop 2, he doubles this amount to 200 g/acre. At harvest time, he rejoices at a very large increase in crop yield.

Crop	Plant Extract (g/acre)	Yield (bushels per acre)
1	100	32
2	200	38

He records his data in a graph.



4. EVALUATE THE SOLUTION.

Farmer Griffin's crop yield is now down only 5%. However, when he includes the fact that he saves money on chemicals, he discovers that he will actually earn more money in the long run.

Farmer Griffin will be more profitable than ever! When he considers that he is also protecting the environment, he feels very good. He decides to share his findings with the other farmers at the State Fair. He offers to help them design alternatives to harmful chemicals.

Technological design is the process that advances the human race. Whether it is a farmer designing a safer way to grow food or an engineer designing a car that uses hydrogen for fuel, technology is critical to the health, comfort, and productivity of our lives.

PRACTICE

1. Name two ways in which technological design and scientific experiments are similar.

   1. _____

   2. _____

2. What is the major difference between technological design and the scientific experiment?

   _____

   _____

3. What are the four steps in technological design?

   1. _____

   2. _____

   3. _____

   4. _____

4. Think of a problem that requires a technological solution.

   _____

   _____

5. Much of the city of Wilmington, North Carolina, lies just above sea level. If the city were struck by a major hurricane, it could be flooded. Design a technological solution that could help save the city in the event of a flood.

   _____

   _____

   _____

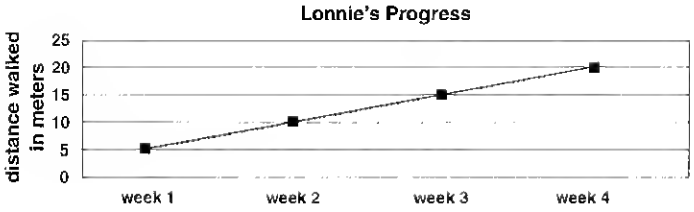
   _____

6. Think of a need in your home or school. Describe and draw a product that could fill this need.

7. How would you test your product?

Chapter 1 Review

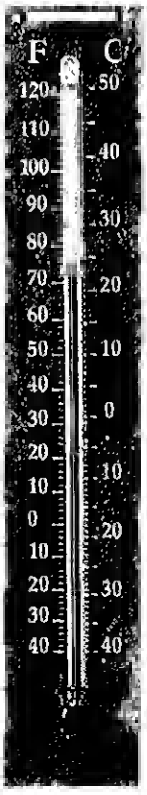
1. Lonnie was in a car accident and must learn to walk again. Each day he works with a nurse to exercise his leg muscles. What conclusion can you draw from the data recorded by his nurse?



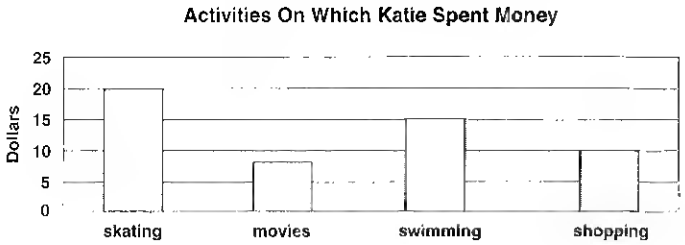
A Lonnie is recovering.
B Lonnie can walk a greater distance after 4 weeks of therapy.
C After 2 weeks, Lonnie can walk 10 meters.
D all of the above

2. What is the temperature according to the thermometer?

A 24°C
B 26°C
C 28°C
D 30°C



3. Katie spent her babysitting money on the following activities. Infer which activity Katie ***probably*** likes best.



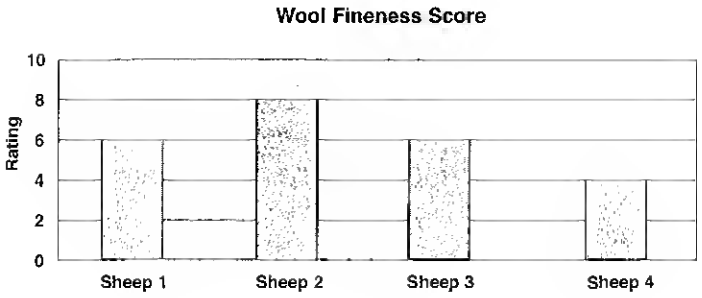
A skating
B movies
C swimming
D shopping

4. You have been asked to judge a sheep contest at the State Fair. A long neck is an indicator of good overall body structure. According to the table below, which sheep has the longest neck?

Sheep	Neck Length
1	15 cm
2	17 cm
3	13 cm
4	14 cm

A 1
B 2
C 3
D 4

5. The fineness of a sheep's wool is graded on a scale of 1 (coarse)-10 (very fine). According to the graph below, which sheep has the finest wool?



A 4
B 3
C 2
D 1

6. Which of the five senses below ***might*** be used to judge fineness?
A sight
B smell
C taste
D touch

7. Based on the neck length and wool fineness data, predict which animal will take home the blue ribbon. (Use graphs in #4 & #5.)
A 1
B 2
C 3
D 4

8. Which of the following is ***not*** a way you could classify sports?
A by strength
B by color
C by aim
D by speed

9. Which of the following is ***not*** a way you could sort fruit?
A by color
B by shape
C by sound
D by texture

10. Which of the following instruments would be used to measure the height of a basketball hoop?
A thermometer
B balance
C graduated cylinder
D meter stick

11. Damion wants to prove to his sister that he is the better speller. Which of the following would be a fair test to prove his theory?
A Damion selects a group of words for both of them to spell.
B Damion's sister selects a group of words for both of them to spell.
C Damion's parents select a group of words for both of them to spell.
D Damion and his sister each choose words for the other to spell.

12. Which of the following contains the steps of technological design in the correct order?
A design the solution, test the solution, state the problem, evaluate the solution
B state the problem, evaluate the solution, test the solution, design the solution
C state the problem, design the solution, test the solution, evaluate the solution
D test the solution, state the problem, design the solution, evaluate the solution

13. Which of the following is ***not*** a component of both scientific experiments and technological designs?
    A They both require a statement of the problem.
    B They both apply new knowledge toward the solution of a problem.
    C They both involve creative design.
    D all of the above

14. The design of a product to solve a particular problem is an example of a _____.
    A technological design
    B scientific experiment
    C product evaluation
    D process skill

15. Which of the following words does ***not*** belong?
    A kilogram
    B meter
    C liter
    D gallon

Use qualitative and quantitative data to answer the following.

16. Describe the smell of these familiar places:

    The swimming pool _____

    The school cafeteria _____

    The park _____

    The woods _____

    The movies _____

    Your grandparent's house _____

    Your friend's house _____

17. Imagine a sunset. How would you describe it qualitatively? Remember to use descriptive words.

_____

_____

18. Think of the sky. What color is it on a sunny day?

19. What color is the sky just before a storm?

20. What does the sky look like at night?

21. Describe the sound of the ocean.

22. Besides the waves, what are some other sounds you hear at the beach?

23. Imagine picking up a handful of dirt. How would it feel?

24. Imagine picking up a handful of mud. How would it feel?

25. Imagine picking up a handful of gravel. How would it feel?

26. Describe the following tastes.

a Hershey's Bar

your favorite snack

your favorite drink

your favorite meal

27. What is your height in centimeters? _____cm

    What is your friend's height in centimeters? _____cm

    What is your teacher's height in centimeters? _____cm

28. Perform the above exercise for comparison. You will need:
    string
    scissors
    metric ruler

    What is the circumference of your head? _____cm

    What is the circumference of your friend's head? _____cm

    What is the circumference of your teacher's head? _____cm

29. Measure the following:

    What is your arm span?_____cm

    What is your friend's arm span?_____cm

    What is your teacher's arm span?_____cm

CHAPTER 2

UNDERSTANDING FORCE AND MOTION

FORCES THAT AFFECT MOTION

Pretend you are at the North Carolina State Fair and are standing in line for your favorite roller coaster. One moment you are standing still. The next moment a carload of passengers gets off the ride, and the line moves forward. In order for you to move forward, your body must overcome **inertia**. Inertia is the tendency of a motionless object—you—to remain motionless.

You must wait in line for your favorite ride. When you finally move forward, your body must overcome inertia.

Inertia is all around you. Every object you see at rest—a desk, a chair, a computer—is under the influence of inertia. To overcome the stillness, a **force** must be applied to an object. A force is a push or pull on an object.

As you step forward in line, you apply a force to overcome your inertia. The force you apply is a **backward push** off the ground with your foot. A series of backward pushes with both feet moves your body forward. As you overcome inertia, you are a body in motion.

Once an object is moving, it takes another force to stop it. Several forces affect motion. A force, like friction, slows objects down. Gravity speeds them up. An object's mass determines how much a force will change its motion. In this section, you will explore **how forces affect motion.**

Gravity

Pretend you are the pitcher of the U.S.A. softball team. You hold a motionless ball as you stand on the mound. Using the force of your arm, you pitch the ball up and forward. The ball does not sail endlessly. In fact, it drops rather quickly—right into the catcher's glove. Strike 1!

You force the ball into the air, but gravity pulls it down.

The force that caused the ball to come down is called **gravity**. Recall that gravity is a force that pulls objects **toward the Earth**. While it is easy to imagine the Earth exerting a force on a softball, it is tougher to imagine that a softball exerts a force on the Earth. Yet this is precisely what happens. The softball has its own gravity, so the Earth and the softball are both pulling together. The larger the mass of the object, the greater its force of gravity. Therefore the softball's mass is too small to have any effect on the huge Earth. The Earth's mass is enormous, so it easily pulls the softball toward itself.

Distance can also affect the force of gravity between two objects. When objects move closer together, the pull on each other grows stronger. As they move farther apart, the pull weakens.

The force of gravity acts between all objects.

If mass increases, the force of gravity increases.

If distance increases, the force of gravity decreases.

For example, when the space shuttle blasted off from the Earth, it went away from the Earth's gravitational pull. When the astronauts unbuckled their seatbelts, they were floating around because the gravitational pull of the Earth was too far away to affect them!

Friction

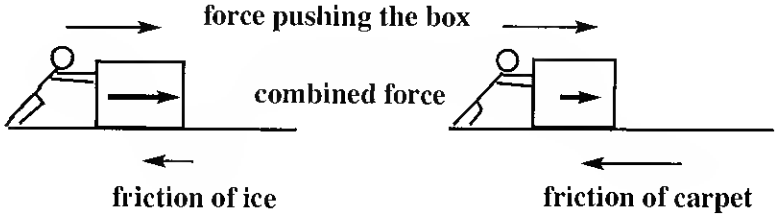
Another force that affects the motion of objects is called **friction**. Friction is an object's resistance to move. Have you ever tried to push a heavy box across a carpeted floor? If so, then you know how difficult it was. What if the floor had been smooth, like ice? Would it have been easier to push the box? Probably so. This is because an ice floor would not have as much friction as a carpeted floor. The friction between the ice and the box would be very low. If you pushed the same box across some carpet, the box would be very hard to slide due to the high amount of friction between the box and the carpet.

Whenever two surfaces touch, friction is created. Friction acts in an opposite direction to the motion of the moving object. Friction will cause a moving object to slow down and eventually come to a complete stop.

Even on a smooth floor, there will still be friction. This is because neither the surface of the box nor the surface of the floor will be perfectly smooth. The impact with which the two objects touch also affects the amount of friction. A heavy box will create more friction than a lighter box.

The force you apply to the box is in one **direction**. The force of friction occurs in the opposite direction. Since two forces moving in opposite directions combine by subtraction, then you will need to apply a force much larger than the force of friction to get the box to move.

Sometimes, **arrows** are used to describe forces acting on an object. The length of the arrow represents the **magnitude** or strength of a force, and the **direction** of the force is given by which way the arrow is pointing. Below is a diagram of the forces involved with sliding a box across ice and carpet. The bold arrows in the boxes represent the combination of the pushing forces and the friction forces. The smaller arrow means the box is not going as fast.



Friction prevents you from coasting forever.

Friction is useful in our lives. What would happen if there was no friction between the bottoms of our shoes and the ground beneath us? We would constantly slip and slide and not be able to walk. Cars and trucks are able to come to a stop because of the force of friction applied by their braking system.

Sometimes, you want to increase friction on purpose. A baseball pitcher will often grab a rosin bag to make his pitching hand less sweaty and slippery. Likewise, a baseball batter will sometimes apply a grip to the handle of the bat. Both of these examples will increase the friction between the hands and the objects. This will allow them to have greater control over the ball and the bat.

Mass

An object's motion depends on the mass of the object. Mass, as you know, is the amount of matter that makes up an object, and matter is anything that takes up space. An objects' mass will determine how much force will change its motion.

If the same force pushes two objects with different masses, the greater the mass of the object the force is acting on, the less force affects it. The object with less mass will move faster and farther.

For example, you have an empty baby stroller and a stroller with a baby. If you push the empty stroller, it will move fast. If you push the stroller with the baby, the mass has increased, so the pushing force affects its motion less. The stroller with the baby will move more slowly.

Which stroller will move faster when pushed with the same force?

PRACTICE

1. Which objects' gravitational pull is greater: (Circle one.)
   a. Earth/moon
   b. textbook/comic book
   c. child/adult
   d. house/office building
   e. lake/ocean
   f. grapefruit/orange
   g. bicycle/motorcycle
   h. bowling ball/tennis ball
   i. ambulance/fire truck
   j. chair/desk

2. Which surface would you rather push a box of books across? (Circle one.)
   a. carpet/tile
   b. wood/concrete
   c. ice/wood
   d. glass/tile
   e. lawn/driveway

3. Name a force that slows motion.

   _____

4. What might happen if a car tried to stop on an icy road? How is this explained by friction?

   _____

   _____

5. Why would small gravel or sand be useful on icy streets?

   _____

   _____

6. Why will there always be friction whenever two surfaces touch?

7. Imagine riding a skateboard down a street. How will friction affect your motion?

8. Think of three examples of activities that you do which require the force of friction. How would these activities change if friction did not exist?

   1.

   2.

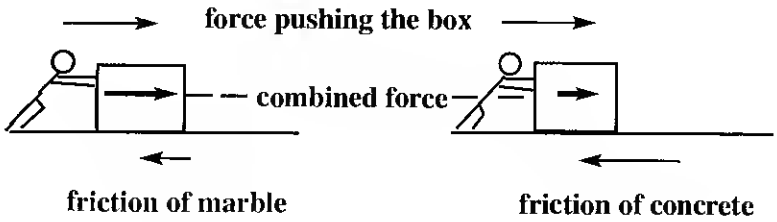
   3.

9. Why does the Earth exert such a strong force of gravity?

10. What force will eventually stop you on a roller coaster?

11. Why do you think a snow skier would put wax on his skis?

12. The diagram below shows a person pushing a box across a marble floor and a concrete floor. In which example would the box travel fastest? Why?



13. Why will a heavy box create more friction than a lighter box?

14. How could the use of wheels reduce the effect of friction?

15. A boy kicks a soccer ball with a certain force. He then kicks a bowling ball with the same force. How does the bowling ball move compared with the soccer ball?

16. Mr. and Mrs. Sanders are moving living room furniture. If they pull a sofa, a Lazy-boy chair, a large coffee table, and a small ottoman with the same amount of force, on which object's motion will the pull have the greatest effect?

17. How does the distance between objects affect the force of gravity between them? Give examples.

MOTION

Motion is generally measured in terms of **speed**. Speed is a measure of how far an object moves in a given period of time. To determine speed, divide the distance traveled by the amount of time taken to cover the distance.

$$\text{Speed} = \frac{\text{distance traveled}}{\text{time it takes to travel that distance}}$$

Remember the line at the fair? Suppose the line moves forward by 10 meters. If it takes you 10 seconds to travel 10 meters, then the speed of the line is:

$$\text{Speed} = \frac{10 \text{ meters}}{10 \text{ seconds}} = 1 \text{meter / second}$$

The line moves forward at a speed of 1m/s.

Another common example of speed is a fast-moving car. You are probably used to thinking of car's movement in terms of miles per hour. For example, you may travel at a speed of 55 miles/hr on the highway. Let us convert this speed into metric units. We will use the following conversion factor to do so.

1 mile = 1.6 kilometers (km)

55 miles/hr x 1.6 km/mile = 88 km/hr

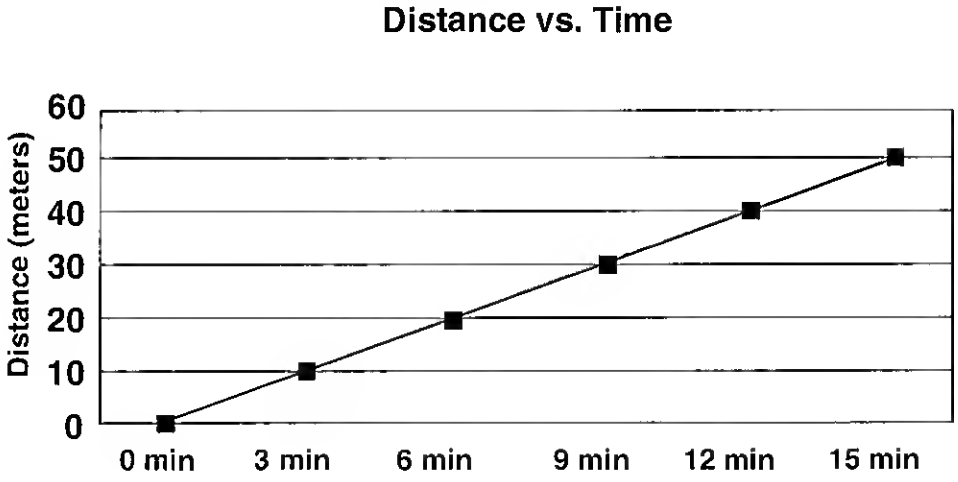
Therefore, 55 miles/hr is the same as 88 km/hr. Next time you travel on the highway, tell the adult you are with that it is safe to "do eighty-eight." When they look at you in surprise, you can tell them you meant "kilometers per hour not miles per hour."

This car is moving fast.

Go back to the slow-moving line at the State Fair. By the time you walk through all the turns, you have traveled more than half the length of a football field, or 50 meters. Assume that you waited in line for 15 minutes and that each ride lasted 3 minutes. You can make a table displaying your progress.

Time (minutes)	Distance (meters)
0	0
3	10
6	20
9	30
12	40
15	50

Using the data from your table, you can plot a graph of distance vs. time.



Average Speed

Next, determine your speed over time as you wait in line at the roller coaster. If you use the normal equation for speed, **speed = distance/time**, your calculated speed will be:

$$\text{speed} = \frac{50 \text{ meters}}{15 \text{ min}} = 3.3 \text{ meters/min} \times \frac{1 \text{ min}}{60 \text{ seconds}} = 0.056 \text{ meters/second}$$

Your speed over time while waiting for the roller coaster is very different from your speed when the line was moving, 1 m/s. Your speed over time is your **average speed**. Your average speed includes changes in speed. For example, sometimes you traveled faster than the average speed, other times you traveled slower than the average speed, and sometimes you were standing still. In fact, you spent much of your 15-minute wait standing motionless in line. Your speed was 0 m/s. When you finally moved, your speed was 1 m/s. Overall your speed was 0.056 m/s.

Traveling in a car provides another good example of average speed. For example, Yolanda drove 800 km in 10 hours. Her average speed was:

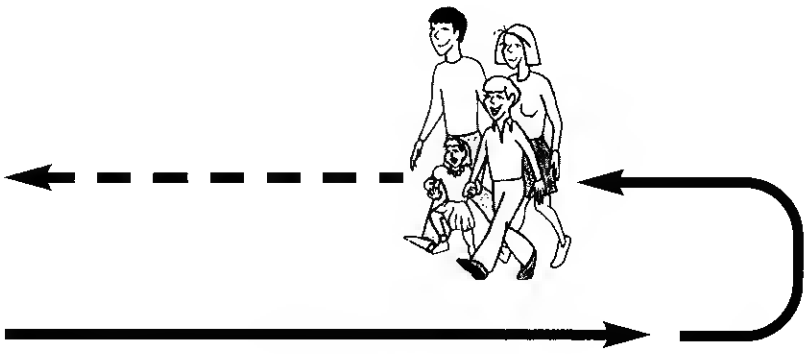
$$\text{Speed} = \frac{800 \text{ km}}{10 \text{ hr}} = 80 \text{ km/hr}$$

Yolanda waits at a red light. This brings down her average speed.

Do you think Yolanda could sit still in a car for 10 straight hours? Probably not. Some of that time was spent at a rest stop. Some was spent waiting at red lights. However, in order to maintain her average speed, some of that time must have been spent traveling faster than her average speed.

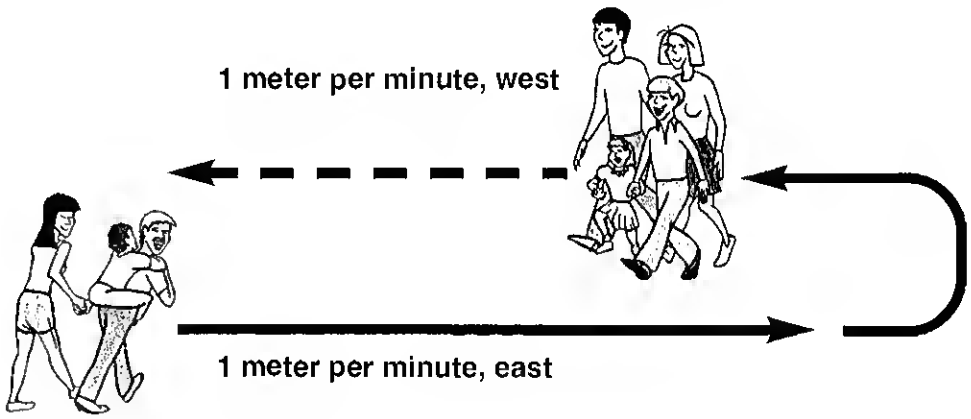
Velocity

Velocity is a measure of speed that takes into account the direction of the movement. For example, imagine your family is moving forward in the line for the roller coaster.



1 meter per minute

Your speed is 1 meter per minute, but your velocity is 1 meter per minute, west. Now imagine that your friend's family gets into line after you. When the line moves, both families travel at the same speed. However, your velocities are different because you are moving in different directions.



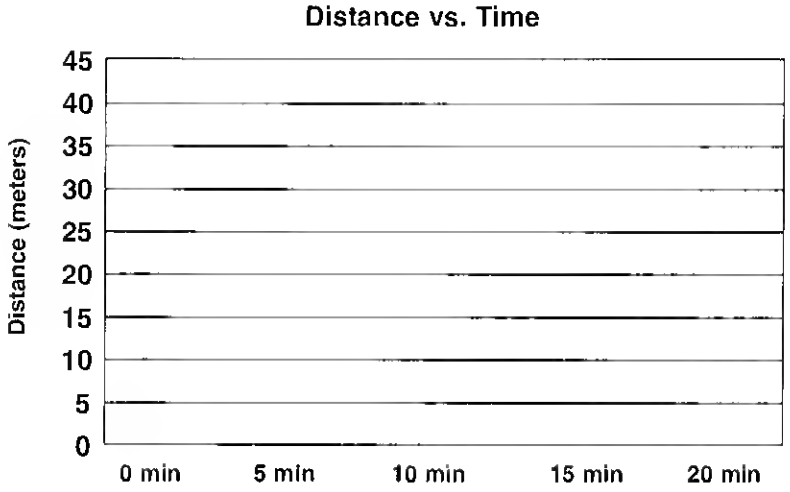
	Speed	Velocity
You	1 meter per minute	1 meter per minute, west
Friend	1 meter per minute	1 meter per minute, east

PRACTICE

1. A common speed when traveling by car is 35 miles/hour. Convert this speed to kilometers/hour.

2. You drive from New Bern to Windsor. If Windsor is 40 km away, and it takes you 1 hour to get there, what is your speed?

3. You are waiting in line for the Ferris wheel. Your movement is detailed in the table below. Draw a graph that represents the distance you traveled over time.



Time (minutes)	Distance (meters)
0	0
5	10
10	20
15	30
20	40

4. You ride the bike trails at the park all day long. The trails run about 30 km. You stop several times to rest, play on the swings, and have lunch. Six hours later, you have finished the trails, and you head for home. What was your average speed throughout the day?

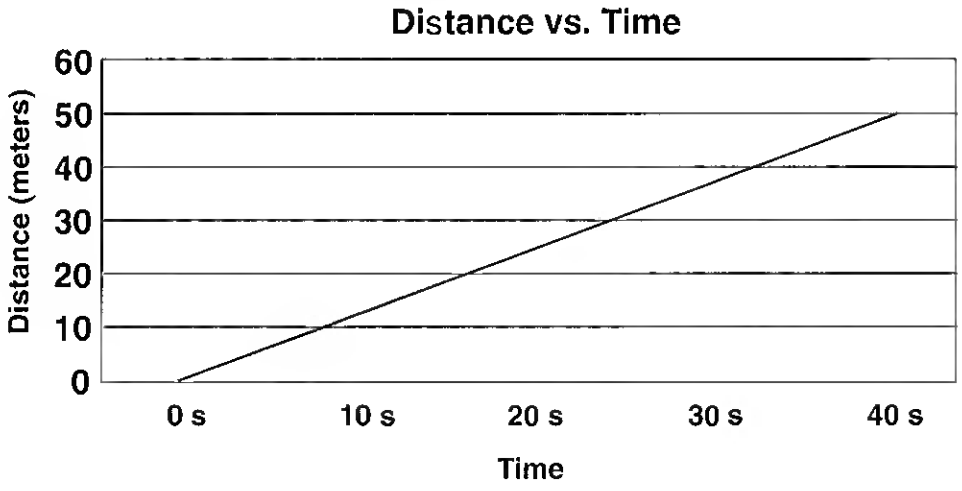
5. Your family decides to drive 720 km to Florida for vacation. It takes 8 hours to get there. What was your average speed?

6. Which of the cars below have the same velocity?
   Car A: Driving 40 km/hr on Route 17 north
   Car B: Driving 80 km/hr on Route 32 north
   Car C: Driving 40 km/hr on Route 64 west
   Car D: Driving 40 km/hr on Route 171 north

7. A car driving south on Interstate 26 travels 160 km in 2 hours. What is the car's average speed? What is the car's velocity?

8. The same car is stopped by road construction. What is the car's speed now? What is the car's velocity?

9. Look at the graph and explain what is happening in your own words.



FACTORS THAT AFFECT SPEED

Remember that speed is defined as rate of motion. It is expressed as:

$$\frac{\textbf{distance}}{\textbf{time}}$$

So if you go 60 miles in one hour, you are speeding along at 60 mph.

$$\frac{\textbf{60 miles}}{\textbf{1 hour}} = \textbf{60 MPH}$$

Now let us look at some things that can affect speed. These things are called **variables.** Imagine you are an experienced snow skier looking for **speed**. Which hill would you rather ski down, A or B?

A **B**

Hill A has a steeper slope than hill B.

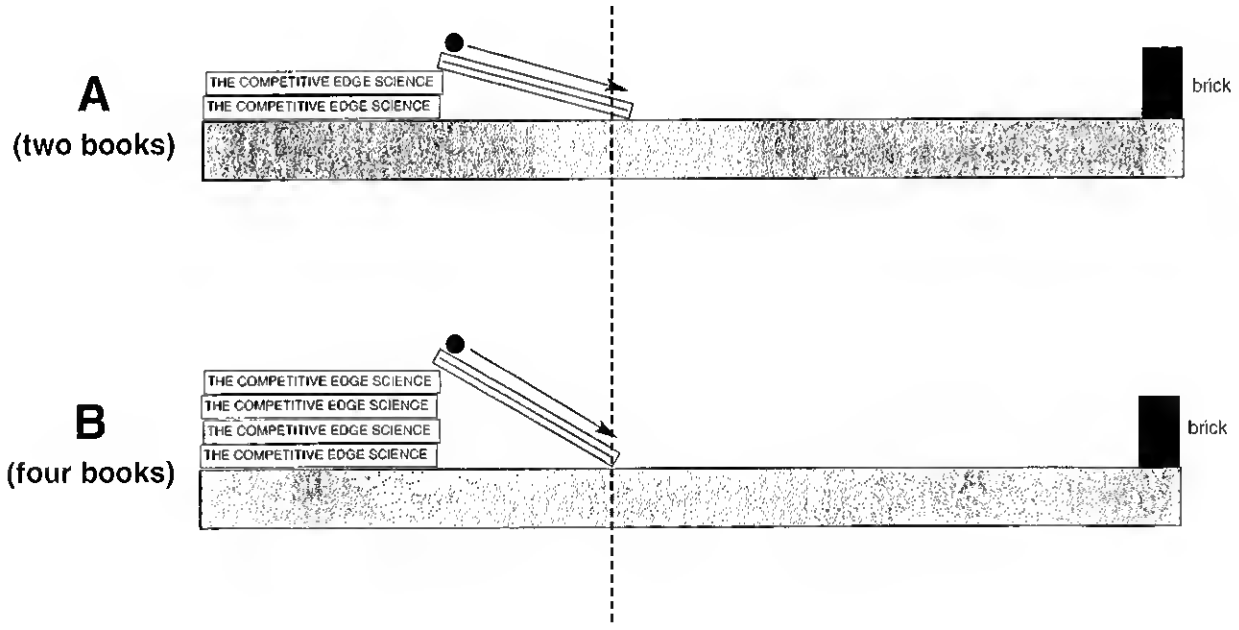
You probably chose A. While both hills are the same height, hill A is much steeper than hill B. This means that the skier on hill A travels a shorter distance than the skier on hill B to come down from the same height. The distance covered while coming down from a height is called the **slope.** The steeper the slope, the faster the skier accelerates. The faster the skier accelerates, the greater the skier's speed.

The **height of these hills is only one variable** that affects the skier's speed. Recall that a variable is a factor that can change the outcome of an event or a test. Can you think of any other variables that might affect the skier's speed? How about **friction** or **weight**? You can easily test the affects of height, friction, and weight on the speed of an object by using a ramp. The only tools you need are:

- 6 books
- grooved ruler
- marble
- brick or block

The Height of the Ramp

First you will test how the height of a ramp affects the speed of an object. Begin by setting two stacks of books side-by-side on a smooth, tiled floor. One stack, labeled A, should have two books. The other, labeled B, should have four books. Next, make ramps by leaning the rulers against the stacks of books as shown. Place a brick or block at the end of each ramp to stop the marbles.

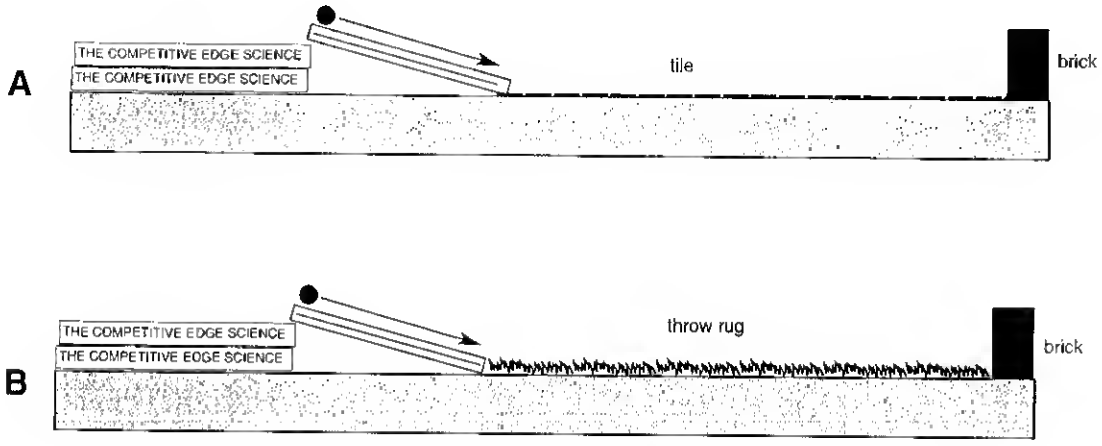


Next, place one marble in the groove at the top of each ramp. Which marble, A or B, do you predict will reach the brick at the bottom of the ramps first? Release both marbles at the same time. Was your prediction correct? If you guessed marble B, you were correct. Marble B had greater speed than marble A because it rolled down a higher ramp. The higher the ramp, the greater the speed.

The Friction of a Ramp

Do you think the skiers in the previous example would enjoy going down the slopes in the summertime? Probably not. Grass and dirt are not very slippery surfaces for snow skis. However, a smooth blanket of snow provides a slick surface that encourages speed.

Let us return to our ramp to see how different surfaces can affect the speed of an object. Imagine you have two ramps of the same height. Ramp A rests on smooth tile. Ramp B sits on a throw rug. If two marbles are released from the ramps at the same time, which one do you think will reach the brick first?



Which surface creates more friction?

If you answered A, you are correct. A marble will roll more quickly over a smooth surface than over a rough one. This is because a rough surface creates more **friction**. Friction is a force that slows the movement of an object over a surface. Friction occurs wherever two surfaces meet and rub against each other. The throw rug has a bumpy surface which creates more friction. This friction decreases the speed of the marble, causing it to reach the brick last. One way to reduce the amount of friction is to add a **lubricant**. A lubricant such as oil coats the surfaces that rub and makes them slippery. This reduces the roughness and the friction so the speed of the marble would increase.

PRACTICE

1. Infer which marble will roll faster: marble A rolls down a 6-book ramp, marble B rolls down a 4-book ramp.

2. Which surface do you think a soccer ball will roll over faster? (Circle one.)

   a. cement or asphalt

   b. asphalt or grass

   c. wood or glass

   d. carpet or linoleum

   e. ice or snow

3. Why can you slide across a kitchen floor in your socks, but not across a carpeted room?

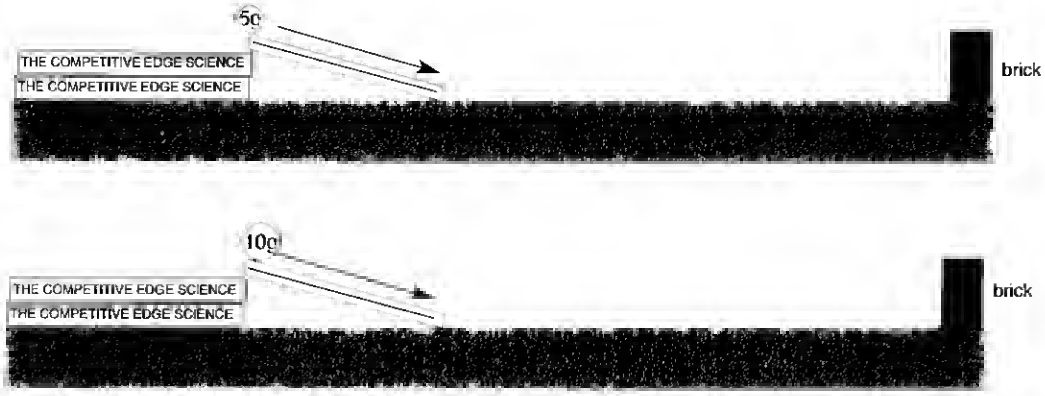
4. What does oil do for your car?

5. Why does your bicycle slow down and stop on a level surface?

THE WEIGHT OF AN OBJECT

Imagine a 105-kg man and a 59-kg woman skiing down the same hill at the same time. Do you think the man will reach the bottom of the hill first? The answer is no. You may think that weight affects the speed with which objects travel downhill, but it does not.

This is easy to test with the ramps. Pretend you have two ramps of the same height. If you release a marble weighing 5 grams and a ball bearing weighing 10 grams at precisely the same time, you will see that they both reach the brick at the same instant. Weight or mass does not affect the speed of falling objects.



If dropped from the same height, these balls will reach the brick at the same time.

To understand why this is true, **you must think of weight in terms of gravity**. Weight is a measure of the pull of gravity on an object. The closer an object is to the Earth, the stronger the pull of gravity. This means that as an object falls, the pull of gravity increases. This increase in force causes an increase in acceleration. **Gravity does not care about the mass** of the object as it accelerates. The increase in acceleration is the same for all objects as they fall closer and closer to Earth. For this reason, you can drop a bowling ball and a basketball from the top of a building, and they will both reach the ground at the same time. Lightweight objects, such as feathers, have a lot of air resistance, which acts against gravity. Acting like a parachute, these objects free fall slowly.

You should be prepared for questions about factors affecting speed. Try to remember the following:

- **The higher the ramp, the faster an object moves down it.**
- **The smoother the surface, the faster an object moves over it.**
- **Weight or mass does NOT affect the speed with which objects fall or move downhill.**

PRACTICE

1. Which variables were controlled when ramp height was tested? weight of marble, height of ramp, roughness of surface

2. Which variable was allowed to change when the roughness of a surface was tested? weight of marble, height of ramp, roughness of surface

3. Which variables were controlled when the weight of the object was tested? weight of marble, height of ramp, roughness of surface

4. A cantaloupe and a soccer ball are dropped from the same height at the same time. Which reaches the ground first?

5. Imagine you drop a ball from a ramp that is 10 ft. high and another ball of the same mass from a ramp that is 5 ft. high. Which ball will reach the ground first? Why?

6. Which of the following does ***not*** affect the speed with which objects fall or move downhill? weight or mass, height of a ramp, roughness of a surface

7. What is the force that pulls an object towards Earth?

8. Two equally weighted objects are dropped from the same height. One ramp is made of wood, and one is carpeted. Which object reaches the ground first? Why?

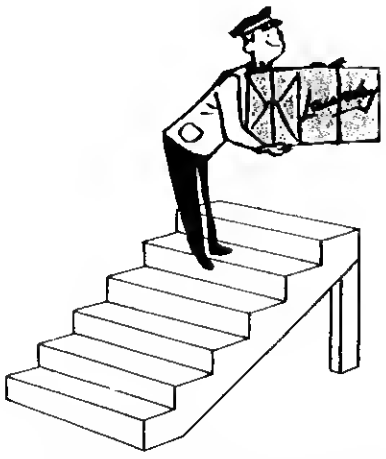
WORK

We use the word work to mean many different things. You may work at school, your parents may work at their jobs, and you may work on homework or chores at home. But for a scientist, work has a specific meaning. It is not what we normally think of as work!

Scientifically, **work** is done only when a force moves an object. **Force** is any push or pull exerted on matter. Force can cause matter to speed up, slow down, or change its direction of motion. Forces give energy to an object. And **energy** can be defined as the ability to do work. Whenever you push, lift, or throw an object, you are doing work. Your force is acting on the object, causing it to change direction and move.

A hammer pounding a nail exerts a force on the nail, causing it to move a certain distance and overcome friction. Work is therefore done.

An additional requirement for work is that the force applied must overcome a **resistance force**, such as gravity or friction. Whenever two surfaces touch, a force called **friction** is created. Friction acts in an opposite direction to the motion of the moving object. Friction will cause a moving object to slow down and eventually come to a complete stop. Gravity is the force that pulls an object downward. Therefore, for work to be done, it must move an object in such a way that it resists the pull of gravity.



The delivery man is doing work because he carries the box up the stairs.

Another requirement for work to be done is that the object must be moved in the same direction as the force applied to the object. If the applied force is upward, then the direction of movement would also need to be upward in order for work to be done.

Normally, holding a heavy box for an hour would be considered hard work. But according to the scientific definition of work, no work is being done because the box is not moving. Carrying the heavy box while walking is not scientific work, either, because the direction of the force is up, but the box is moving forward.

PRACTICE

1. How is the scientific definition of work different from the common definition of work?

2. How are force, work, and distance related?

3. Use the **common** definition of work to think of three specific activities that you would define as work.

4. Use the **scientific** definition of work to think of three specific activities that you would define as work.

5. A man pushes as hard as he can against a wall. The wall does not move. Has the man done any work, scientifically? Explain your answer using the terms work, force, distance, and motion.

6. Assume an athlete throws a javelin high into the air. Is work done? Explain in terms of force, direction, gravity, and distance.

7. Assume a 5th grade girl is holding books still as she carries them while walking to class. Is she doing work? Explain in terms of force, direction, gravity, and distance.

UNBALANCED FORCE

Kicking a ball requires force.

Force is any push or pull exerted on matter. Force can cause matter to speed up, slow down, or change its direction of motion. Forces give energy to an object. For example, if you wanted to kick a ball, you exert a force on that ball and cause it to move. Increasing the strength behind your kick will increase the force you exert and will make the ball move faster. Someone who wants to catch the ball will also use force to stop the ball's motion. Someone else might use force to deflect, or change the direction, of the ball. All of these examples involve force.

Imagine that you had to pull something heavy—maybe a wagon with your brother in it. To get the wagon to move, you would have to exert a very large force on it. But what if you were not strong enough? You would need to enlist someone else to help you—perhaps another brother. Now, he would not be able to pull the wagon by himself, either, but by adding his strength, you could combine forces and pull the wagon.

Would the boy in the wagon be able to pull his brother with his own force?

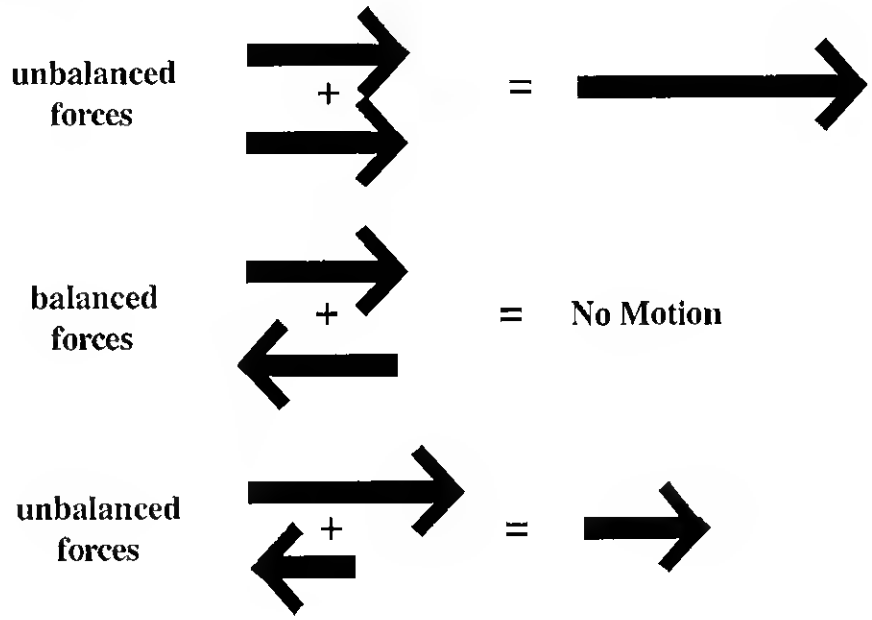
In this example, two forces (yours and your brother's) would be exerted on the wagon in the same direction. When two forces are acting *in the same direction*, they combine by addition. The total force on the wagon is the sum of the separate forces. When the total force on an object is moving in one direction, then the force applied is called **unbalanced**. Any unbalanced force changes the motion of an object.

What would happen if your brother decided to pull the wagon in the opposite direction? Of course, this would make it difficult to move the wagon in your direction. When two forces act in *opposite directions*, they combine by subtraction. The wagon will move in the direction of the greater of the two forces and the total force applied to the wagon

would be the difference in the two separate forces exerted. If you were bigger and stronger than your brother, then your force would be greater and the wagon would still move in your direction, although much slower. This is another example of an unbalanced force, because the total force on the object causes movement in one direction.

What would happen if your brother was just as strong as you? In other words, what would happen if the forces that you and your brother exerted were equal? In this case, if you subtract one force from the other, then no matter how you subtract it, the result will be zero. This means that there would be no force acting on the object, and the wagon will not move. Forces that are exerted in opposite directions and are equal in size are called **balanced forces**. When forces are balanced, there is no change in motion.

In the diagram below, the combination of forces is illustrated. The strength of the force is indicated by the length of the arrow, and the point of the arrow shows the direction of the force applied.



PRACTICE

1. What is force?

2. How are motion and force alike?

3. How can you produce a balanced force?

4. How can you produce an unbalanced force?

5. Give three examples of activities you engage in which require you to create a force.

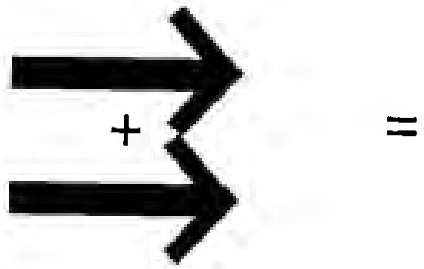
   1.

   2.

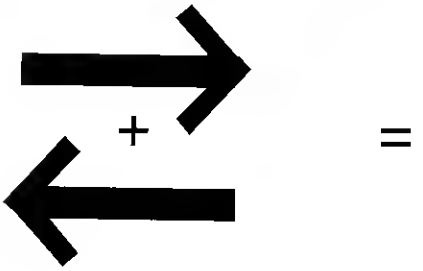
   3.

6. Label the following forces as balanced or unbalanced. Then, draw an arrow which will represent the strength and direction of the resulting force.

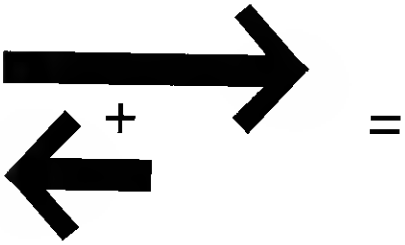
a.



b.



c.

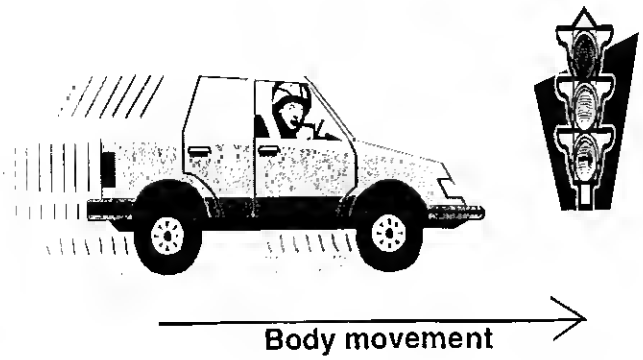


NEWTON'S THREE LAWS OF MOTION

1. Newton's First Law of Motion

An object with no unbalanced force acting on it will either remain at rest, or continue moving at constant speed in a straight line unless a force acts on it. This is sometimes known as the **Law of Inertia**. **Inertia** is an object's resistance to move.

For example, let us say you are in a car that suddenly stops. Even though the car is slowing down, your body will lunge forward. This lunging effect is caused by your body's inertia. Your body wants to continue to go fast. In another example, when a car turns, your body leans the way the car was going before the turn.



2. Newton's Second Law of Motion

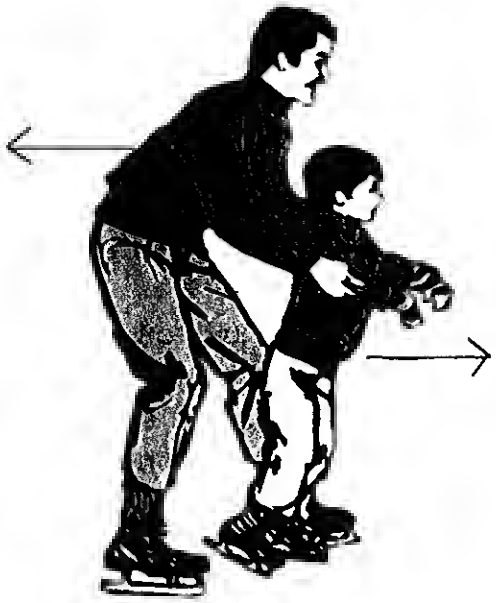
This is sometimes known as the **Law of Acceleration**. It states that when an unbalanced force is applied to an object, the object accelerates. This means if an object is moved by a force, it will move in the direction of the force. Also, the greater the force, the faster the object moves. Your mom pushing you on the swing will cause you to move faster than if your little brother pushes you. The amount of force increases your acceleration.

3. Newton's Third Law of Motion

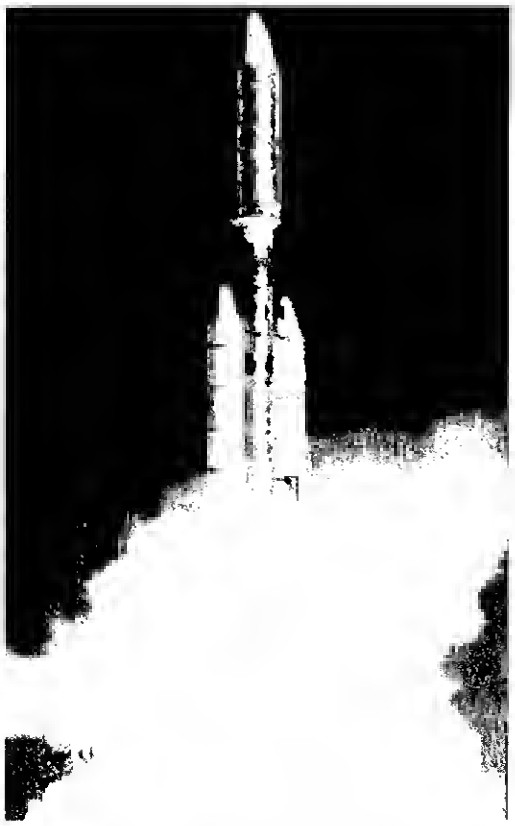
For every action (force), there is an equal and opposite reaction (force). For example, let us say you are standing on a skateboard. If you decide to jump forward off the board, the board will travel backwards as you push the board with your foot.

For another example, take two people on ice skates. Both are stopped when one decides to push the other. The skater who was being pushed will travel in the direction of the push while the other will travel in the opposite direction.

Two people are on ice skates and one is behind the other. Both skaters have the same mass. You just read what will happen when one pushes the other, one will travel forward while the one who pushed will travel backward. Since they have the same weight, and they had the same force acting on them, then they will travel at the same speed away from each other. If one skater is significantly larger than the other, then they will still travel in opposite directions, but the larger skater will travel slower.



If the father pushes the son, who will travel the fastest? Why?



How does Newton's Third Law explain why the rocket goes up?

Newton's Three Laws of Motion can be applied to the way a rocket works.

Which Law is being demonstrated as the rocket sits on the launch pad prior to launch? It would be the First Law. An object remains at rest unless another force acts on it.

Which Law explains why the rocket travels up? Newton's Third Law explains this. For every force, there is an equal and opposite force. When the rocket is launched, fuel is burned out of the back of the rocket. As fuel pushed out of the back of the rocket, the rocket is pushed in the opposite direction. The rocket will continue at the same acceleration due to the First Law again.

These same laws apply to someone jumping off the ground. Your feet pushing off the Earth cause an opposite force on your body moving you up in the air, until gravity pulls you back.

How do rockets get into orbit? Imagine you are standing on top of a tall mountain. If you throw a rock straight out away from you, it will continue to travel away from you as it is being pulled to the Earth. If you throw it a little faster, it will still hit the Earth, but it will be farther away. If you threw it faster still, it will hit the Earth farther away and so on. Since the Earth is curved, no matter how fast you throw the rock, gravity will cause the rock to curve towards the center of the Earth.

But if you were to throw the rock at the right speed, the rock will have the same curvature as the Earth. It would never hit! Therefore, if a rocket has enough power during liftoff, then it can obtain a fast enough speed to remain in orbit around the Earth. The rocket remains in orbit because of the combination of the rocket's inertia and the force of gravity.

PRACTICE

1. In each of the sentences below, which of Newton's Three Laws is described? Explain.
   a. Two cars hit head on. _____
   b. When a bullet is fired, the gun recoils. _____
   c. It is difficult to push a stalled car. _____
   d. A magician pulls the tablecloth out from a table full of dishes. _____
   e. A car turns left, and you sway right. _____
   f. The momentum from a bat is transferred to a ball. _____
   g. A car suddenly stops, and you strain against the seat belt. _____
2. Suppose a car travels at a constant 10 m/s. How far would it move in 1 hour?

   _____

   _____
3. How does Newton's Third Law explain how a rocket gets into orbit?

   _____

   _____

4. If you are in a car that is struck from behind, you can receive a serious neck injury called whiplash. Using Newton's Laws of Motion, explain what happens. How can a headrest reduce whiplash?

5. Lamar has a new wagon and asks Bobby to pull him in it. Bobby says, "No way. The harder I pull on the wagon, the more the wagon pulls back on me, according to Newton's Third Law of Motion." What can Lamar say to get Bobby to start pulling?

Chapter 2 Review

1. An object that is moving must have overcome the force of _____.
   A gravity
   B inertia
   C laziness
   D stillness

2. You are walking in the hall and an adult runs into you walking at the same speed. What will ***most likely*** happen?
   A The adult will fall back.
   B You will both fall down.
   C You will fall back.
   D You will both stop.

3. You leave science class and walk 10 meters to math. From math you walk 5 meters to the bathroom. What is the total distance walked?
   A 50m
   B 15m
   C 5m
   D 2m

4. A push or pull on an object is a/an _____.
   A inertia
   B bad idea
   C force
   D gravity

5. A/An _____ must be applied to make an object move.
   A force
   B inertia
   C yank
   D stretch

6. The force that keeps us on Earth is _____.
   A inertia
   B magnetism
   C gravity
   D duct tape

7. What is the speed of a man jogging at 12 km south in 30 minutes?
   A 24 km/hr south
   B 24 km/hr north
   C 1 km/min west
   D 24 km/hr

8. What is the speed of a car that travels 40 km north in 30 minutes?
   A 40 km/hr, north
   B 40 km/hr
   C 80 km/hr, north
   D 80 km/hr

9. What is the velocity of a child walking 14 blocks east in 30 minutes?
   A 28 blocks/hour
   B 28 blocks/hour, east
   C 14 blocks/minute
   D 14 blocks/minute, east

10. Which of the following is ***not*** a factor that affects speed?
    A friction
    B gravity
    C inertia
    D force

11. If you drop a bowling ball and a soccer ball off a tall building, which will hit the ground first?
    A bowling ball
    B soccer ball
    C They will reach the ground at the same time.
    D neither

12. A large man and a small man bungee dive off the same cliff at the same time. Who will fall faster?
    A large man
    B small man
    C They will fall at the same rate.
    D neither

13. A force which slows down the movement of surfaces sliding over each other is _____.
    A friction
    B force
    C gravity
    D inertia

14. A skydiver opens his parachute as he nears the ground. The force that helps him fall gently to the ground is _____.
    A work
    B slope
    C friction
    D mass

15. Velocity is a measure of speed that takes into account _____.
    A the weight of an object
    B the direction of movement
    C the force of the movement
    D the acceleration of an object

16. You and your family go to the park. If your mom and your younger brother take turns pushing you on the swing, ***most likely***, your speed _____.
    A will be the same regardless of who pushes you
    B will be greater when your little brother pushes you
    C will be greater when your mom pushes you
    D will be less when your mom pushes you

17. A builder is designing a wheelchair ramp for a portable classroom. The ***best*** choice of building materials to reduce friction on the wheelchair is _____.
    A many small boards nailed together
    B a wooden ramp covered with carpet
    C a wooden ramp covered in sandpaper
    D a wooden ramp with a smooth plywood surface

18. Which of these would be the ***best*** lubricant to reduce friction on your bicycle gears?
    A sand
    B alcohol
    C water
    D oil

19. A skier will ***most likely*** travel faster down a slope ___.
    A with hard packed snow
    B with loose powdery snow
    C with bumpy patches
    D with wet snow

20. The Earth exerts a force on a flea equal to the flea's weight, W. According to Newton's Third Law of Motion, how much force does the flea exert on the Earth?
    A much less than W
    B a little less than W
    C exactly W
    D a lot more than W

21. The velocity of a car traveling south at a constant speed of 39 km/h is _____.
    A constant
    B zero
    C increasing
    D decreasing

22. The property of an object that resists change in its motion is _____.
    A mass
    B inertia
    C velocity
    D gravity

23. Newton's First Law of Motion says that _____.
    A force equals mass times acceleration
    B forces occur in pairs
    C mass exerts force
    D a body at rest will remain at rest

24. Newton's Second Law of Motion says that _____.
    A mass has inertia
    B for every action, there is an equal and opposite reaction
    C velocity has a cause
    D force causes acceleration

25. Increasing which quantity would increase the inertia of an object?
    A its distance from the Earth
    B its air resistance
    C its mass
    D its shape

26. The statement "forces occur in pairs" comes from _____.
    A Newton's First Law of Motion
    B Newton's Second Law of Motion
    C Newton's Third Law of Motion
    D Aristotle's analysis of force

27. What does speed measure?
    A how fast an object is moving
    B the direction in which an object is moving
    C the weight of a moving object
    D the distance traveled by an object

28. Since the weight of a steel marble is 3 times more than a glass marble's, when dropped from the top of a building at the same level and at the same time, the steel marble will _____.
    A speed up 3 times faster than the glass marble
    B have a velocity 3 times faster than the glass marble
    C fall with the same speed as the glass marble
    D fall with less speed than the glass marble

29. According to Newton's First Law of Motion, if a rock tied to a string is whirled in a circle, which of the following is responsible for the rock flying off?
    A inertia
    B gravity
    C work
    D friction

30. Which of the following is a force that reduces the motion of an object?
    A inertia
    B friction
    C gravity
    D density

31. Which of the following is defined as a push or a pull on matter which can change its direction?
    A gravity
    B mass
    C force
    D weight

32. Forces acting in the same direction combine by _____, while forces acting in opposite directions combine by _____.
    A balancing, unbalancing
    B subtraction, addition
    C unbalancing, balancing
    D addition, subtraction

33. When a force is exerted on an object, work is done ***only*** if the object _____.
    A moves
    B remains still
    C is heavy
    D is small

34. Which of the following affects an objects' motion?
    A what the object is near
    B the object's width
    C the force acting on the object
    D the object's color

35. A fifth grader hits a ping pong ball and then a baseball with the same force. How does the ping pong ball move compared to the baseball?
    A slower and farther
    B slower and not as far
    C faster and not as far
    D faster and farther

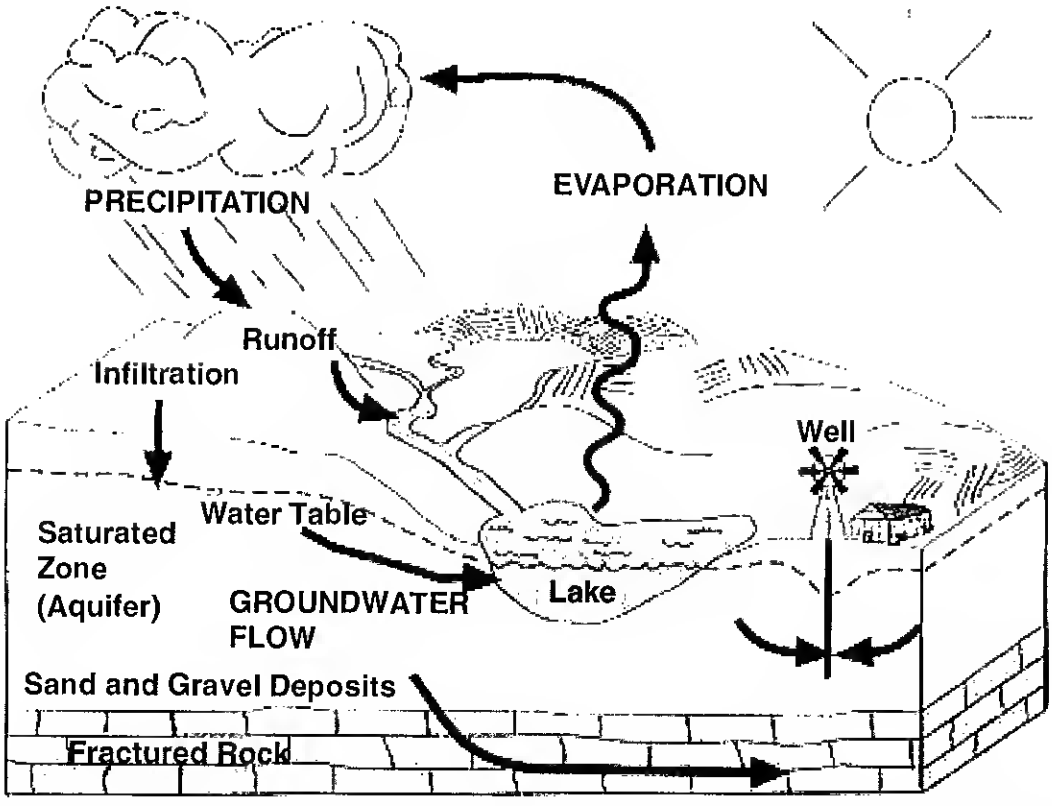
36. If you decrease an object's mass, you _____.
    A decrease its force of gravity
    B increase its force of gravity
    C change its color
    D change its movement from east to west

37. What effect does friction have on the motion of an object?
    A It slows the motion.
    B It speeds up the motion.
    C There is no effect.
    D It slows the motion, then speeds it up.

CHAPTER 3
MATTER AND ENERGY

THE WATER CYCLE

Water is needed by all living things. Water from oceans, lakes, and rivers repeatedly moves from the Earth to the air and then back again. This never-ending process is called the **water cycle**. The water cycle begins when the Sun warms large bodies of water, causing the surface water to evaporate. Since warm, moist air is lighter than cold air, much of the water vapor rises. High in the atmosphere, the temperature is very cold. Therefore, warm air becomes colder as it rises. The change in temperature causes the water vapor to condense onto dust, smoke, or salt particles in the air. These droplets pool together, forming **clouds**.



In the water cycle, precipitation flows into groundwater or surface water and then evaporates into the atmosphere. The evaporation then becomes precipitation and the cycle continues.

Eventually clouds get too big and heavy to float in the air. When this happens, water droplets fall from the clouds to the ground. Much of the precipitation falls right back into the oceans, where the cycle begins again.

Precipitation, evaporation, transpiration, and condensation are the steps in the water cycle that continue over and over again. It provides us with water in different forms—gas (water vapor), liquid (water), and solid (ice).

Water from oceans is constantly being moved into the air through a process called **evaporation**. Evaporation occurs when water from the Earth is warmed by the Sun. Water molecules in liquid form gather greater energy. If the energy of movement is great enough, the molecules will escape and become **water vapor**. There is always water vapor in the air, even though you cannot see it.

If you have ever noticed a puddle on your back porch after a rain, it will gradually evaporate into the air. If the temperature is hot, it will evaporate faster.

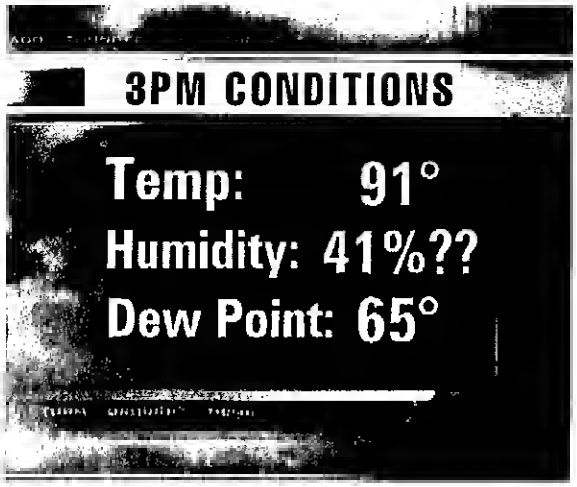
You have probably walked across the grass early in the morning and your shoes got wet. If it did not rain the night before, where do you think this water came from?

At night, after the Sun goes down, the temperature drops, the water molecules slow down. This coldness causes the water vapor in the air to **condense**. Condensation is the process by which water vapor changes back into a liquid. The water on your shoes after your early-morning walk is condensed water vapor that was once in the air.

If you take a hot shower, you may notice that your bathroom mirror will "fog up." This is actually water vapor that has condensed into tiny droplets of water on your mirror. Eventually the water vapor droplets will evaporate and clear up.

Warm air can hold more water vapor than cool air. You know that summer days in North Carolina are usually very muggy and humid. In fact, this warm air can hold up to five times as much water vapor as cold air on a winter day! The amount of water vapor in the air is called **humidity**.

Air at the same temperature can have different amounts of water vapor in it. The amount of water vapor in the air can be stated as a percentage. One hundred percent humidity means that the air is **saturated** with the maximum amount of water vapor that it can hold at a certain temperature. This could mean that it is raining. Fifty percent humidity means that the air is holding half of the water vapor that it can at that temperature. This way of expressing humidity is called **relative humidity**. It tells how much water vapor is in the air compared to the total that could be in the air at a given temperature.

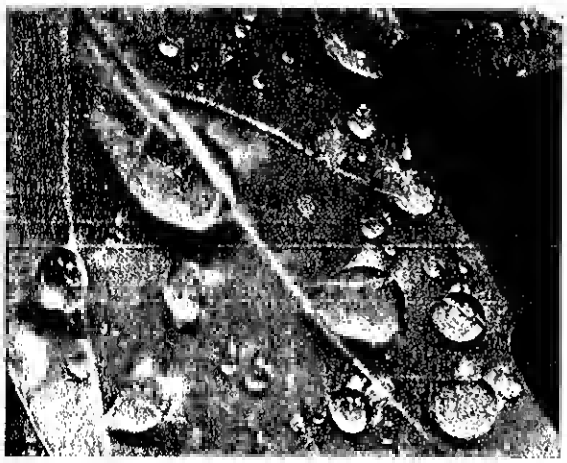


That weatherman must be crazy! He says the humidity is only 41%. I just came in from working outside, and I'm wringing wet with sweat, and the air is so thick that you could cut it with a knife!

Have you ever felt this way on a sweltering summer day?

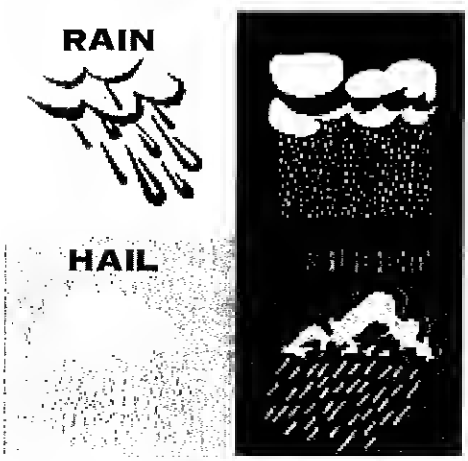
Relative humidity means the percentage amount of water the air is holding compared to the total amount it *could* hold at that temperature. The trick is relative humidity is relative to the *temperature*, and the warmer the air is, the more moisture it can hold.

Sometimes at night the air near the ground cools down. If the relative humidity reaches 100 percent, condensation will occur. The temperature at which this happens is called the **dew point**. The water droplets that form on the grass and other surfaces are called **dew**. If it is below freezing when the condensation occurs, the water droplets will form **frost**. Frost can be hazardous to plants, especially if the plants have recently begun to bloom. Sometimes farmers will cover their plants or even use heaters in large orchards to protect the trees from the effects of frost.



The dew on this leaf is caused by condensation.

Water that falls to the surface of the Earth is called precipitation. Some clouds, like cumulonimbus clouds, result in the formation of **precipitation**. The tops of some clouds are made of ice crystals. Air movement can mix these ice particles with water droplets from the lower layers. The ice crystals become heavier, until they fall towards the Earth. Falling through cold air creates **snow**. Falling through warm air creates **rain**. Falling through warm air and then through a patch of cold air results in **sleet.** Hail forms when updrafts hurl ice crystals upward again and again. As the crystals fall, they are coated with water. As they rise, the water freezes. This process happens over and over until **hail** is formed.



Dew and frost are not considered to be precipitation because they form directly on the surface of the Earth. Water that falls to Earth provides a source of life for organ-

isms and contributes to the process of weathering and erosion of minerals and rocks. Much of the precipitation goes into the ground and is called **groundwater**. If it does not go into the ground, it is called **runoff**. Runoff water is also called **surface water**. Runoff and groundwater can return to the ocean by first draining into a stream and then into rivers and finally into the ocean. Runoff water collects salt and other minerals from the soil as it travels downhill. Rivers deposit both the water and the minerals into the oceans. Here, the water cycle begins again. However, while water is evaporated back into the air, the salts are left behind. Therefore, runoff water adds to the salt concentration of the oceans.

Some of the water in the water cycle is used by plants. The groundwater is absorbed by the roots of the plants. The unneeded water is evaporated from tiny openings called stomata in the leaves in a process known as **transpiration**.

The water cycle is an important component of an ecosystem. The cycle is a neverending process that has continued since the Earth was formed. Water evaporates from the surface of the Earth from oceans, lakes, ponds, rivers, and moist land. This water vapor condenses and forms clouds. When the clouds contain more water than they can hold, precipitation in the form of snow, ice, hail or rain falls to the Earth. As much as two-thirds of all precipitation evaporates back into the atmosphere. The process then starts over.

PRACTICE

1. What are some other examples of evaporation that you have observed?

2. Why are rain and snow considered precipitation but not dew or frost?

3. Describe what it would feel like outdoors if it were 32°C and 90% relative humidity.

4. Describe the process of condensation and evaporation.

5. What is the difference between humidity and relative humidity?

6. Describe the possible dangers of frost to plants and trees.

7. What is the dew point and dew?

8. What are the forms of precipitation?

9. Explain groundwater, runoff, and surface water.

10. Explain transpiration.

Check the box of the term that matches the description for #11-18.

11. Water forms on the outside of a cold drink.
    ❑ evaporation ❑ condensation ❑ precipitation

12. Water disappears from a puddle.
    ❑ evaporation ❑ condensation ❑ precipitation

13. Frost covers the grass.
    ❑ evaporation ❑ condensation ❑ precipitation

14. A blanket of snow covers the grass.
    ❑ evaporation ❑ condensation ❑ precipitation

15. The water level goes down in a fish tank.
    ❑ evaporation ❑ condensation ❑ precipitation

16. Ice crystals form on a window.
    ❑ evaporation ❑ condensation ❑ precipitation

17. A town is flooded by a rainstorm.
    ❑ evaporation ❑ condensation ❑ precipitation

18. This process increases the salt concentration of oceans.
    ❑ evaporation ❑ condensation ❑ precipitation

19. How are snow and sleet formed?

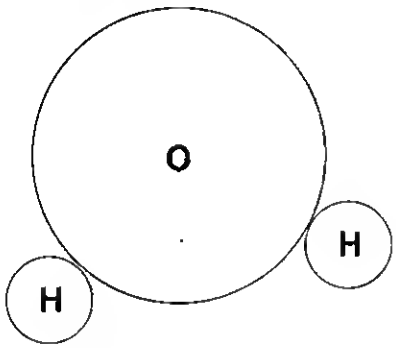
WHAT IS MATTER?

Everything everywhere in the universe is made of **matter**. The sun is a giant, burning ball of matter. The ocean is a deep, watery pool of matter. You are a walking, talking body of matter. Everything is made of matter, including the air you breathe.

While there are many different kinds of matter, all matter is similar in some important ways. For example, all matter has mass and volume. Recall that mass is the amount of material in an object. Volume is the amount of space taken up by an object. Even the smallest speck of dust has volume.

Another similarity among matter is that it is made of simple building blocks called **atoms**. Atoms are the tiniest particles of matter. When two or more atoms join together, they form molecules. All matter is made of atoms grouped into molecules.

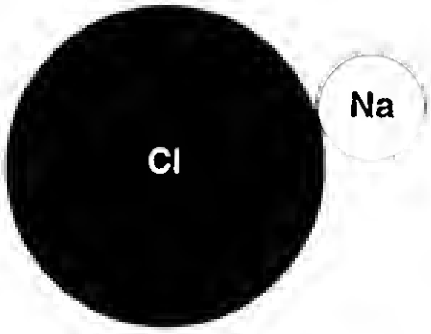
Water Molecule



H_20 = Water

2 Hydrogen (H) atoms and 1 Oxygen (O) atom make up water.

Salt Molecule



NaCl = Salt

1 Sodium (Na) atom and 1 Chlorine (Cl) atom make up salt.

Atoms combine in many different ways.

With so much in common, how can there be so many different kinds of matter? The answer lies in how *molecules* are grouped together. Just as atoms join together to form molecules, molecules join together to form matter. It is the different ways that molecules combine that make up the different kinds of matter. For example, atoms of hydrogen and oxygen float separately in the air. But if two atoms of hydrogen join with one atom of oxygen, you get water!

PRACTICE

(1-5) Which item has the greater **mass** (circle one)?

1.	bowling ball	beach ball
2.	baby doll	baby
3.	magazine	book
4.	cake	cupcake
5.	you	your teacher

(6-10) Which item has the greater **volume** (circle one)?

6.	bowling ball	beach ball
7.	television	VCR
8.	magic marker	crayon
9.	desktop computer	laptop computer
10.	tennis ball	football

11. LEGO's are building blocks that you can combine in many different ways. In this manner, they are similar to atoms and molecules. Name something else that can be grouped together in different ways.

12. Get a bag of mixed-flavor gumdrops and a box of toothpicks. Connect the gumdrops and toothpicks in as many different ways as you can think of. In a way, you are seeing how a molecule looks. Draw some of your results.

13. What does all matter have in common?

14. Why are there so many different kinds of matter?

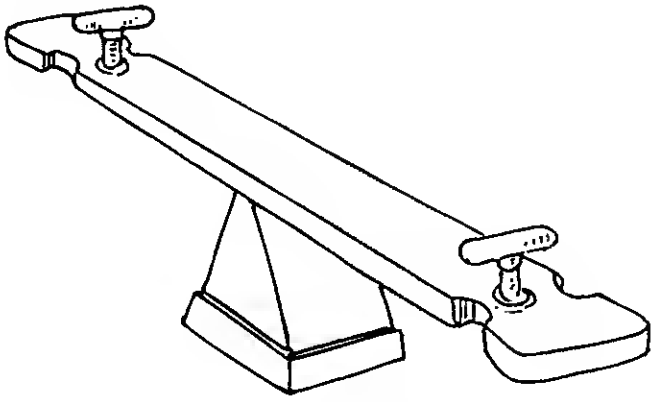
15. What do atoms form when they group together?

THE THREE STATES OF MATTER

Look at your desk or table. Do you see it vibrating? Of course not! However, you may be surprised to learn that the atoms and molecules in your desk are not sitting still. They vibrate back and forth constantly. These tiny vibrations at the level of atoms and molecules allow matter to exist in three states. The three states of matter are **solids**, **liquids**, and **gases**.

Solids

A **solid** is matter with a definite volume and shape. The shape of a solid doesn't change even when you pick it up. This is because the molecules of solids are tightly packed and exactly arranged. The tight arrangement leaves only a little room for molecules to move. This book you are reading is a solid. An ice cube, a skateboard, a CD-ROM, and a teeter totter are also solids.



This teeter totter is a solid.

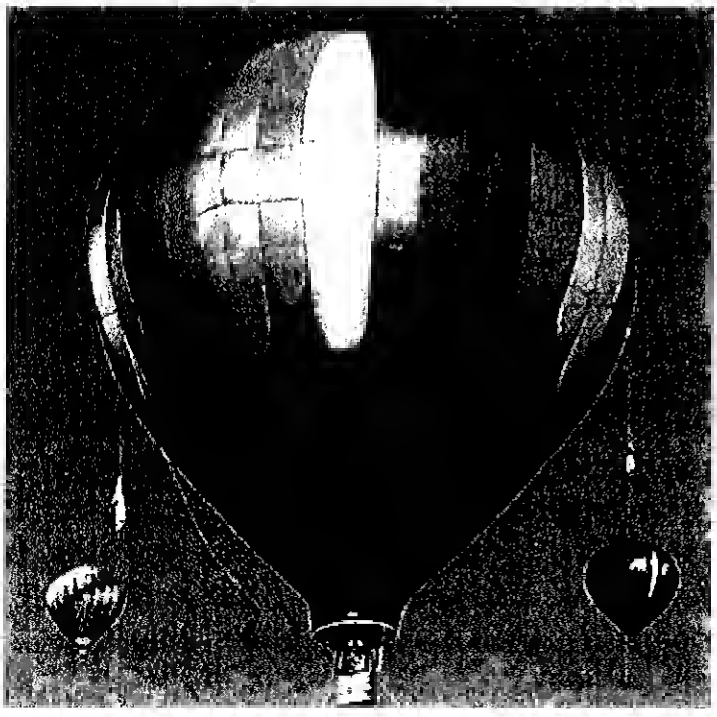
Liquids

A **liquid** is matter with a definite volume but no exact shape. Pour some juice from a tall, skinny glass into a short, fat cup. The juice changes shape very easily. However, you still have the same volume, or amount, of juice. The molecules in liquids are farther apart than in solids. In addition, they are not arranged in a rigid order. This means the molecules in liquids have more room to move. This allows liquids to "flow." A liquid takes the shape of whatever container it is in.

Water is a liquid.

Gas

A **gas** is matter with no definite volume or shape. Gas molecules are spread even farther apart than in liquids or solids. This means they have lots of room to move, and they do so very quickly. Gases spread out until they hit the walls of their container. Most of the time you cannot see gas, but it is all around you. The air you breathe, the bubbles in a fish tank, and the air in a balloon are all examples of gas.



Invisible air fills this balloon.

PRACTICE

(1-15) Is it a **solid**, a **liquid**, or a **gas** (circle one)?

1.	shampoo	solid	liquid	gas
2.	ice	solid	liquid	gas
3.	hair	solid	liquid	gas
4.	steam	solid	liquid	gas
5.	Pepsi®	solid	liquid	gas
6.	oxygen	solid	liquid	gas
7.	popcorn	solid	liquid	gas
8.	Snickers® bar	solid	liquid	gas
9.	pepper	solid	liquid	gas
10.	wind	solid	liquid	gas
11.	paper	solid	liquid	gas
12.	chalk	solid	liquid	gas
13.	helium	solid	liquid	gas
14.	water	solid	liquid	gas
15.	bubbles	solid	liquid	gas

16. Try pouring a liquid into containers of different shapes. Does it look like you have a different amount of liquid each time?

_____

_____

17. Explain why many solids feel hard.

_____

_____

18. Think of a way you can prove there is air in the room.

19. Why do liquids "flow"?

20. Why does a gas have no definite volume or shape?

21. A substance with molecules that are very far apart is probably a _____.

22. A _____ is matter with a definite volume but no exact shape.

THE CHEMICAL NATURE OF MATTER

Properties of Matter

Everyone is constantly making **observations**. When one observes, hearing, seeing, tasting, touching and smelling are involved. Observations usually involve looking at the characteristics of a material or making a measurement of a material without changing the identity of the material. The **physical properties** of the material are what one is observing.

Everyone is constantly making observations.

Everything that has mass and takes up space is called **matter**. When you observe the physical properties of matter, there are several things you see. **Color** is the first thing you notice. Next you notice the **shape**. Does it have an **odor**? How does it **feel**? Is it **smooth** or **rough**? Can it **dissolve/melt** in water? These properties can be identified by using your senses.

Some properties of matter must be **measured**. The **length**, how long something is, can be measured by a tape measure or meter-stick. **Weight** (mass), how much material is in an object, may be measured by using a scale. Remember, the weight of any object is equal to the weight of all its parts together. If you have a pear that weighs 153 grams, even if you cut it in half, it still weighs 153 grams. The sum of the two parts will be equal to the weight of the whole pear.

These two halves weigh the same as the whole pear.

Volume measures the amount of space an object takes up, and **density** is the amount of mass a material has in a given volume. Both of these can be found by using mathematical formulas. **Temperature**, how warm something is, can be measured by using a thermometer.

Other physical properties include conductivity, magnetism, and malleability. **Conductivity** is a measure of the ease with which electrons move through a material. Metals are good conductors of heat and electricity. The physical properties of magnetism and malleability also refer to metals. The ability of a material to be attracted or repelled by another material due to a magnetic field is called **magnetism**. The ability of a material to be hammered or rolled into sheets is called **malleability**.

CHANGES IN MATTER

Matter is constantly undergoing change. Two types of changes affecting matter are physical and chemical changes. **Physical changes** are changes in size, shape, or physical state (**phase**) of matter. An example of a physical change is when water boils and turns into steam. **Chemical changes** involve changes in the actual identity of the substance. For example, when iron is exposed to oxygen and moisture, it undergoes a chemical reaction and turns to rust. In a physical change, no change is made in the identity of the matter. In chemical changes, however, a new material is formed.

Another way to determine whether a physical or chemical change has taken place is to see if you can reverse the change by physical means. Silly putty can be smashed back into its container and Crisco will harden back into its original form. Some **mixtures** are physical changes. A mixture is matter made of two or more materials. When you combine rocks and water, no new materials are made. The rocks and the water can be separated so that you just have *rocks* and *water*. Chemical changes such as scrambled eggs changing back into a raw egg inside an eggshell or the chocolate syrup in brownies changing back into liquid form will not occur.

Physical Changes

Matter may exist in four phases: solid, liquid, gas, or plasma. **Solids** consist of particles that do not freely move; they have a definite shape and volume. Liquids consist of particles that may flow over one another; they have a definite volume, but no definite shape. **Gases** consist of particles that may move freely in any direction; they have no definite shape or volume. The **plasma** stage occurs at very high temperatures and is found in laboratories, fluorescent bulbs, and in lightning.

Changes in phase occur as particles change their **kinetic energy**, or energy of motion. Solids gain kinetic energy when the temperature is increased. If the temperature gets high enough, the solid will turn into a liquid. This phase change is called **melting**, and the temperature at which it occurs is called the **melting point**. The opposite phase change occurs if the liquid is cooled to a solid. This is called **freezing**, and the temperature is called the **freezing point**. The freezing point and melting point of a pure substance occur at the same temperature and may be used to identify the material.

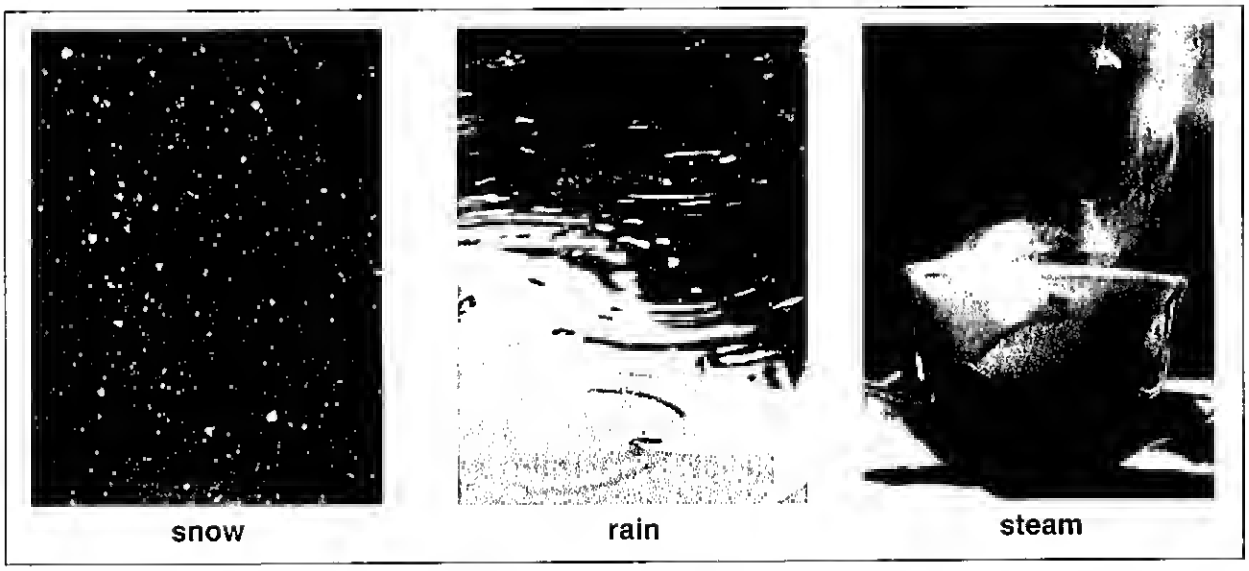
A liquid may gain enough energy to become a gas. This is called **vaporization**. **Evaporation** is vaporization of a liquid left in the open air. A special type of vaporization is called **boiling**. Boiling occurs when the vapor pressure of a liquid equals the atmospheric pressure on its surface. The temperature at which this occurs is the **boiling point**. Pure liquids can be identified by their boiling points. The boiling point will change depending on the atmospheric pressure. For example, boiling at higher elevations will occur at lower temperatures because the atmospheric pressure decreases as you go higher.

Getting a liquid to the boiling point takes a large amount of heat to get the temperature to increase. The specific heat of a substance is the amount of heat (in joules) needed to raise the temperature of 1 kg of a substance 1°C.

When gaseous particles lose energy, they may return to the liquid phase. This process is called **condensation**. You can see condensation when you breathe onto a mirror. The water droplets collected on the mirror have been condensed from their gaseous state. Some solid materials like dry ice and moth balls do not ordinarily melt but, rather, change directly into a gas from the solid phase. This process is called **sublimation**.

Melting, freezing, vaporizing, boiling, condensing, and sublimating do not involve changes in the properties or identity of the materials; only the phase of matter. Therefore, these types of changes are physical changes.

$$\text{solid } H_2O \underset{\text{freezes}}{\overset{\text{melts}}{\rightleftharpoons}} \text{liquid } H_2O \underset{\text{condenses}}{\overset{\text{boils}}{\rightleftharpoons}} \text{gaseous } H_2O$$



For example, think about the physical changes that occur as water goes from solid to liquid to gas form. Water can be frozen, like snow, it can be liquid, like rain, or it can be gaseous, like the steam coming from a hot cup of water.

Chemical Changes

A **chemical property** is any characteristic that gives a substance the ability to undergo a change that will result in a new substance. Chemical changes involve changes in the identity of a substance. In a chemical change, a new material is formed. This new material has different properties than the original material. Chemical changes are usually called **chemical reactions**. In a chemical change, the atoms in a material break bonds and form new bonds. The atoms themselves do not change identity, but they rearrange themselves into different substances, having different characteristics.

Evidence that a chemical change or reaction has occurred includes:

1. Color change.
2. Gas produced (bubbles form, but not from boiling).
3. Precipitate (insoluble solid) is formed.
4. Light given off.
5. Heat given off or taken in (temperature changes on its own).

Evidence that a **chemical reaction** occurred includes heat absorbed or released. An **endothermic reaction** absorbs energy. If you feel the test tube, it will get cold. Cold packs used on injuries work because of endothermic reactions. Usually a container inside of the cold pack breaks, releasing a chemical that reacts with the other chemical in the cold pack, causing the cold pack to get very cold. An **exothermic reaction** occurs when heat is given off. The test tube that the reaction occurs in will get very warm.

Some chemical reactions give off light. That is the light that you see in many fireworks. Another evidence of a chemical reaction is a change in color from the original materials. A chemical reaction could also produce gas, which is evidenced through bubbling. A final evidence of a chemical reaction is mixing two solutions and seeing the formation of a solid. This solid is called a **precipitate**.

PRACTICE

1. Distinguish between a physical and a chemical change in matter.

2. Identify as physical or chemical changes. Label as "P" or "C."

_____ Ice melts.	_____ A nail rusts.
_____ Sugar ferments to alcohol.	_____ Steam condenses.
_____ Water boils.	_____ Alcohol evaporates.
_____ Wood burns.	_____ Antacids neutralize stomach acid.
_____ Rain freezes.	_____ A rock is crushed.
_____ Sugar dissolves in water.	_____ Gasoline burns in an engine.
_____ A firefly glows.	_____ A battery produces electricity.
_____ A precipitate forms.	_____ Acid on marble produces CO_2.
_____ Moth balls sublimate.	_____ Milk ferments to buttermilk.

3. Describe the solid, liquid, and gas phases of matter in terms of shape, volume, and arrangement of atoms. Use water as an example.

4. Describe the plasma phase of matter.

5. Water freezes at 0°C. Water also melts at 0°C. How can the freezing point and melting point for water be the same?

6. Explain the difference between evaporation, condensation, and sublimation.

7. How does heat change the state of matter?

8. Water vapor from the air condenses on a cold glass. The condensed water collects in a puddle at the bottom of the glass. Many hours later you notice that the puddle is gone. Infer what happened to the condensed water.

9. What is steam?

10. Why does a Popsicle melt in your mouth?

11. What causes condensation?

12. Where does evaporated water go?

13. How can you turn liquid water into a solid?

14. How can you turn liquid water into a gas?

15. What causes molecules to move faster?

16. What is it called when water from the air turns into a liquid?

17. Draw water, as you most often see it, in each of its three states.

GAS

SOLID

LIQUID

18. Walk around your school and look for objects with condensation on them. Record them below:

19. How do scientists use the melting and boiling points of unknown matter?

20. What is the term used to describe liquid water changing into water vapor?

21. When a substance boils, do its molecules move faster or more slowly than when the substance is in the solid state?

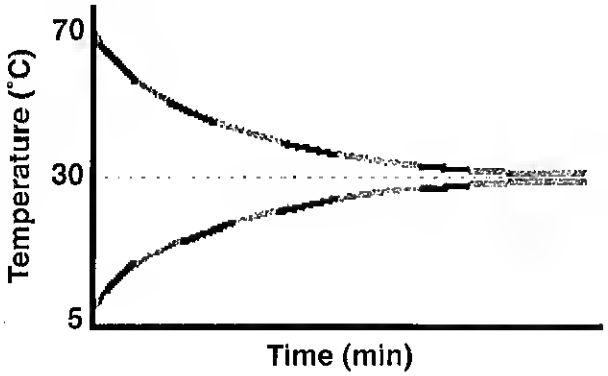
22. The melting point of lead is 327°C. Infer the freezing point of lead.

TEMPERATURE AND HEAT FLOW

Heat energy is a basic form of energy which involves the internal motions of molecules of matter. **Heat energy** is therefore the sum of the kinetic energy of all of the particles of matter. **Temperature**, on the other hand, is the measure of the average kinetic energy of the particles of matter. Particles that move faster have more kinetic energy and therefore, more heat. They are farther apart than cooler molecules, which move slower and generate less heat. Particles of matter are always in motion, except at absolute zero, the temperature at which motion ceases to exist.

Heat and temperature are related, but are not the same thing. A drop of water and a pot of water may be at the same temperature, but the pot of water contains more heat energy. In both cases, the water molecules move with the same average kinetic energy (temperature), but the pot contains more water molecules and therefore more heat.

Heat flows from a warmer object to a cooler one. Objects become cooler as heat moves out of them, and become warmer as heat moves into them. When warmer and cooler objects are put together, the warmer ones lose heat and the cooler ones gain heat until they are the same temperature.



When warm and cool objects are put together, they will eventually be at the same temperature.

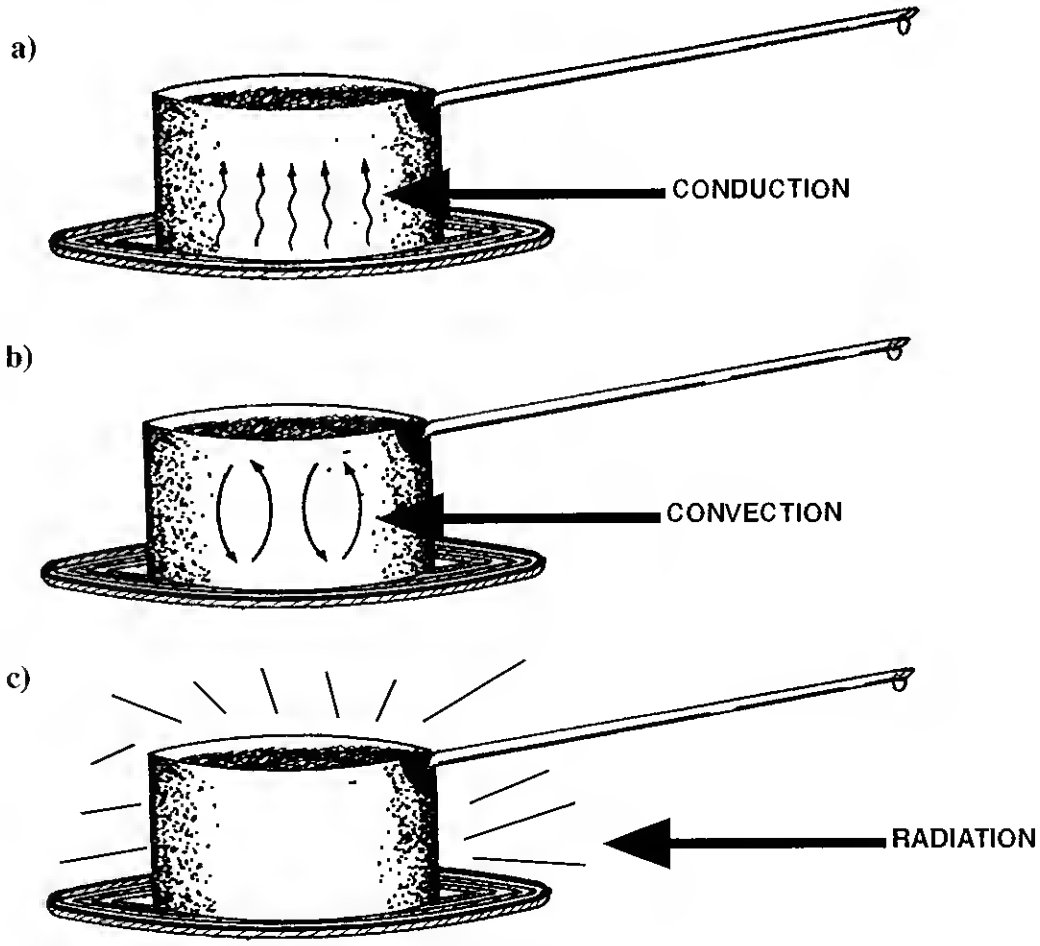
An important concept in understanding the nature of heat energy is to understand how heat is transferred. **Heat flow** is the movement of heat from areas of higher temperature to areas of lower temperature. This heat flow may occur in three ways: through conduction, convection, and radiation.

Conduction of heat occurs when heat is transferred by the collision of particles. The particles must touch in order to transfer heat by conduction. As fast-moving molecules collide with slow-moving molecules, heat energy is transferred from the faster molecules to the slower molecules. Because all matter is made up of molecules, conduction can take place in solids, liquids, and gases. But it takes place best in solids, because the molecules of a solid are in direct contact with one another.

Good heat conductors, like metals, transfer heat easily by this method. Dark pavement is another good heat conductor. If you have ever stepped barefoot onto hot pavement, you know what a good heat conductor it is! If a material conducts heat well, it also conducts electricity well. Copper is an excellent metal conductor. Copper wiring is common in the transfer of electricity.

Convection of heat occurs when heat is spread by movement of large amounts of fluid particles. These particles may be liquid or gas. When the liquid or gas is heated, the molecules begin to move faster. As the molecules move faster, they move farther apart. This means that the heated fluid is less dense than the surrounding fluid. Matter that is less dense will be displaced by denser and cooler matter and will therefore rise. The Earth's atmosphere and homes are generally heated by the convection currents of air.

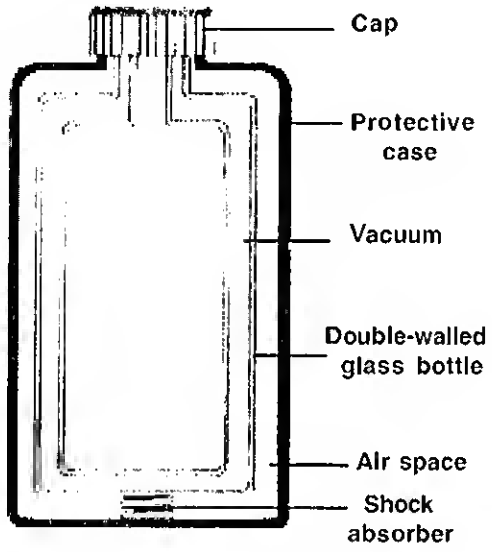
Radiation of heat occurs when heat is transferred through empty space by means of electromagnetic waves. This type of heat travels outward from its source in all directions. Energy from the sun warms us in this manner, provides light, and the ability for producers to make their own food through photosynthesis. Radiation also occurs as heat you feel from an open fire, a hot stove, or a candle flame.



Conduction, convection, and radiation are demonstrated in the figure. Conduction **(a)** is caused by the contact of the pan with the burner. Convection occurs, as shown by the arrows in **(b)**, when the hotter liquid on the bottom rises to the top. Radiation **(c)** is demonstrated by the heat that is given off in all directions by the pan, without direct contact being necessary.

Insulators, like styrofoam, reduce the flow of heat. Glass, wood, plastic, and rubber are examples of good insulators. Air is another good insulator. This is why it is important to wear several layers of clothing in cold weather. The layers of clothing trap air, which insulates your body against heat loss.

A thermos bottle is an example of an insulator. It keeps liquids hot or cold by preventing heat flow. The plastic case and the air space reduce conduction. The vacuum, an empty space with no air, prevents heat loss through convection. A special coating on the surface of the bottle reduces heat flow by radiation.



A thermos bottle uses the concept of insulation to keep liquids cold or hot.

PRACTICE

1. How can two containers of water have the same temperatures but different amounts of heat energy?

2. Why do you think the bottoms of pots and pans are sometimes made of copper?

3. How does radiation explain why you can cook a hotdog over a fire even if the flames do not touch the hotdog?

4. Identify the type of heat flow in the following examples:

   A A pan left on a burner gets hot.

   B A warm air mass flows into an area.

   C A kitchen gets hot after a whole day of cooking.

5. What will ***most likely*** happen when you pour hot tea in an icy glass?

Chapter 3 Review

1. In the evening when you go outside, the grass is dry. It does not rain overnight, but in the morning it is wet. What has happened?
   A evaporation
   B deposition
   C clouds
   D condensation

2. The _____ is a never-ending process that recycles water.
   A carbon cycle
   B water filter
   C water cycle
   D air cycle

3. If it is below freezing when condensation occurs, the water droplets will form_____.
   A frost
   B dew
   C snow
   D hail

4. When water hits the land, some water is _____. The rest runs off.
   A released
   B absorbed
   C evaporated
   D condensed

5. Water that falls to the surface of the Earth, either in solid or liquid form, is called _____.
   A dew
   B frost
   C precipitation
   D condensation

6. Water that is in the form of a gas is called _____.
   A water vapor
   B oxygen
   C ice
   D condensation

7. Water vapor that condenses on the surface of the Earth as a liquid is called _____.
   A frost
   B rain
   C ice
   D dew

8. When you exhale on a cold day and see your breath, it is due to _____.
   A evaporation
   B condensation
   C precipitation
   D runoff

9. The water cycle includes _____.
   A photosynthesis, evaporation, and condensation
   B rain, precipitation, and condensation
   C evaporation, the Gulf Stream, and the jet stream
   D evaporation, condensation, and precipitation

10. What is transpiration?
    A the change of a substance from a gas to a liquid
    B the change of a substance from a liquid to a gas
    C the evaporation of water through openings in leaves
    D the water being transferred from the ground to the ocean

11. What is humidity?
    A the amount of moisture in the atmosphere
    B how warm the air is in the atmosphere
    C the amount of rain in a certain time
    D the amount of cloud cover

12. What are the simple building blocks that make up matter?
    A solids
    B liquids
    C gases
    D atoms

13. Which of the following is ***not*** made of matter?
    A ruler
    B bubbles from a can of soda
    C air
    D They are all made of matter.

14. What is condensation?
    A when you make something smaller
    B when liquid water turns into a gas
    C when water vapor turns into a liquid
    D when water turns into a solid

15. Predict what will happen if condensed water sits around long enough.
    A It will boil.
    B It will evaporate.
    C It will turn into ice.
    D It will stay the same.

16. What test should a scientist ***not*** perform to identify an unknown piece of matter?
    A determine the melting point
    B determine the boiling point
    C determine the freezing point
    D determine the taste

17. Solids are good conductors of heat because _____.
    A the molecules of solids are packed closely together
    B the molecules of solids are far apart
    C the molecules of solids are moving rapidly
    D they know how to get the job done

18. Which is true of radiation?
    A It occurs mainly in gases.
    B It is the reason liquids flow.
    C It occurs when a hot object emits, or gives off, heat.
    D It allows objects to change from a liquid to a solid.

19. The state of matter that flows and takes the shape of its container is a _____.
    A molecule
    B solid
    C gas
    D liquid

20. The state of matter with no definite volume or shape is a _____.
    A solid
    B molecule
    C liquid
    D gas

21. Water vapor in the air is known as _____.
    A temperature
    B humidity
    C ice
    D air

22. Melting, freezing and boiling are called _____.
    A physical changes
    B chemical changes
    C radiation
    D convection

23. A good conductor of heat is _____.
    A metal
    B plastic
    C wood
    D styrofoam

24. The upstairs of a house is usually warmer than the downstairs because heat rises. This is due to _____.
    A convection
    B condensation
    C conduction
    D radiation

25. The Sun heats the Earth in a process known as _____.
    A conduction
    B convection
    C radiation
    D condensation

26. The amount of matter in an object is called its _____.
    A volume
    B mass
    C density
    D dimension

27. A solid changes to a liquid by _____.
    A evaporation
    B melting
    C freezing
    D sublimation

28. Which of the following ***does not*** involve a physical change?
    A Iron rusts.
    B A pellet of lead is sliced in two.
    C Water is heated and vaporizes.
    D Ice melts in a cup.

29. Which of these is a physical change?
    A burning fuel
    B rotting wood
    C melting sugar
    D souring milk

30. Which of these is a chemical change?
    A boiling water
    B photosynthesis
    C crushing of rock
    D sublimation of moth balls

31. Which of the following materials is ***best*** described as a mixture?
    A sugar
    B water
    C air
    D salt

32. The type of change in size, shape, or phase of matter is called a _____.
    A physical change
    B precipitate
    C conduction
    D chemical change

33. Which of the following ***does not*** include a liquid phase?
    A condensation
    B melting
    C sublimation
    D evaporation

34. When a substance is heated, its molecules _____.
    A move faster and farther apart
    B move slower and closer together
    C stay in the same place
    D become larger

35. In which type of heat flow does heat transfer directly from one substance to another?
    A radiation
    B convection
    C conduction
    D conversion

36. Explain how a conductor is different from an insulator.

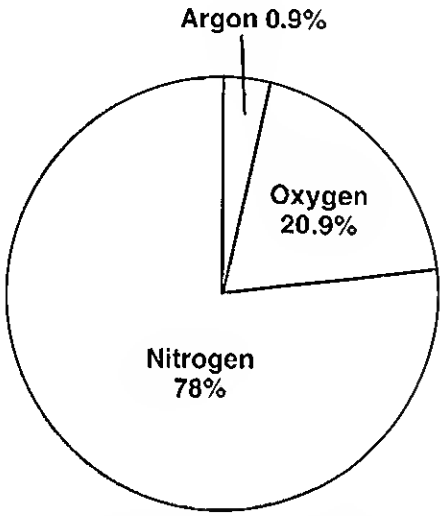
37. You are given a mixture to separate. It contains sand, sugar, pepper, metal filings, and two different sizes of pebbles. Describe a procedure to separate this mixture using the tools below.

water	magnet
bowl	fine mesh net
sieve	

CHAPTER 4
UNDERSTANDING WEATHER AND CLIMATE

THE ATMOSPHERE

We live in an invisible ocean of air. This is called the **atmosphere**. It is a mixture of gases. Nitrogen is the most common (78%), followed by oxygen (20.9%) and argon (0.9%). Small amounts of other gases are also present, such as carbon dioxide and water vapor. These last two gases are present closer to the surface of the Earth.



The primary gases in the atmosphere

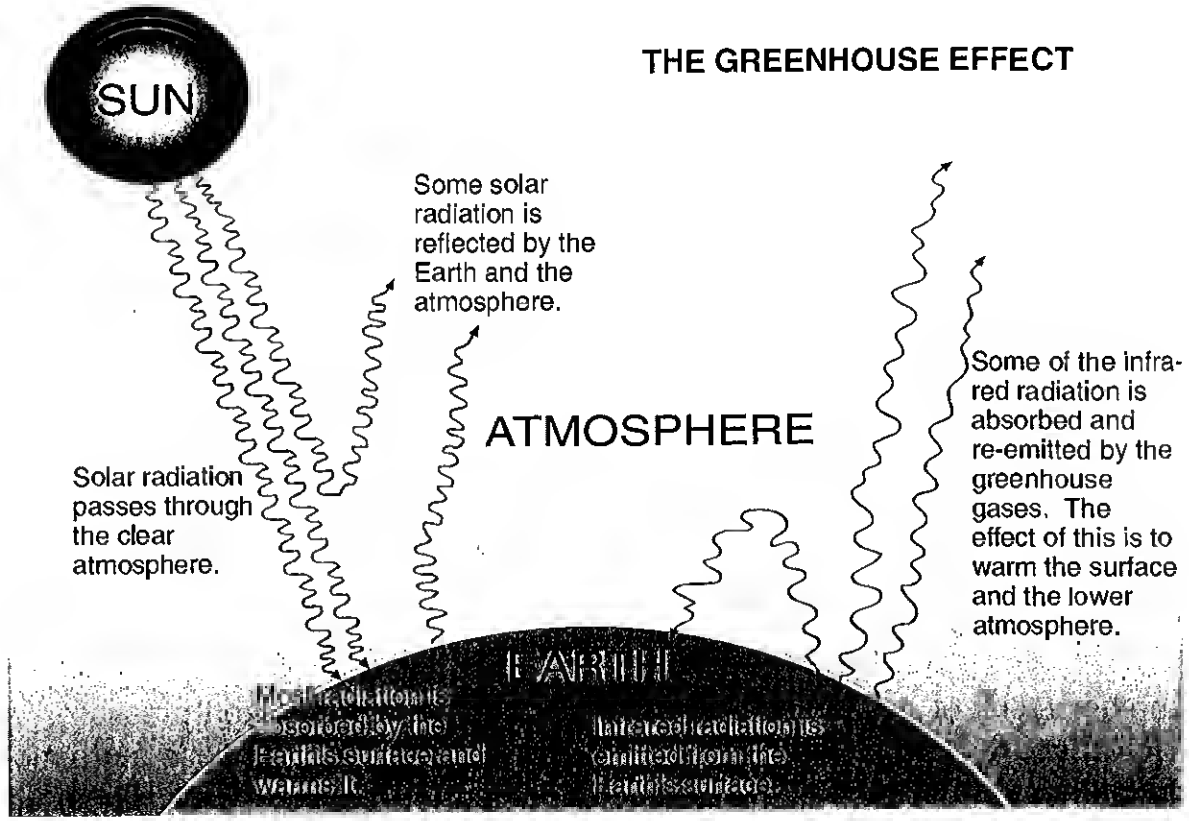
The gases that make up our atmosphere are made of individual **molecules** that move freely. As gas molecules move about, they spread outward and upward. However, there are more molecules near the surface of the Earth because of the force of gravity. The further up they go, the less dense the molecules become. In other words, the atmosphere thins out as you go higher.

Another result of gas molecules moving about is that they exert pressure. **Atmospheric pressure** is produced by the molecules hitting a surface. Since more molecules are found near the surface of the Earth, the pressure is highest here. Higher up, there are fewer and fewer molecules present, and so the pressure is less and less.

Sometimes, as we change our **altitude**, or height, we respond to the change in pressure. The most common change is that our ears seem to "pop." You may have noticed this happening to you if you have ridden on a plane or even a ride at an amusement park. The pop is caused by a tube behind your ear adjusting to the changes in the atmospheric pressure. It does not mean that your ear literally "pops," it just sounds that way.

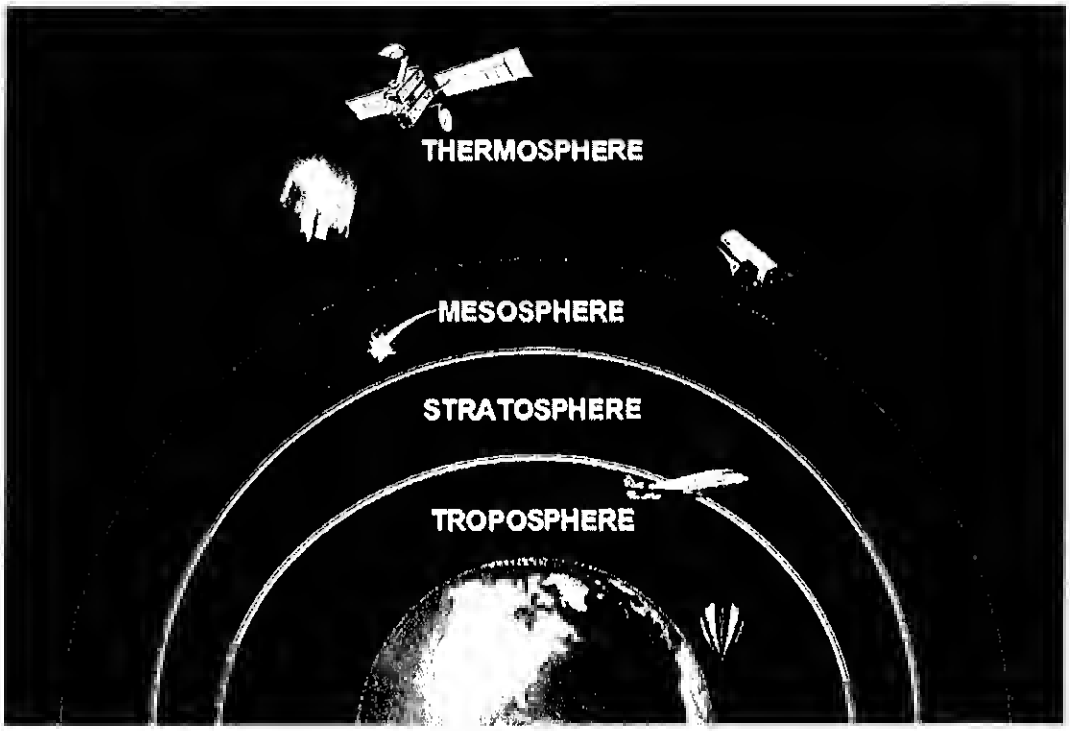
Atmospheric pressure can be measured by using a **barometer**. This device shows how strong atmospheric pressure is at the surface of the Earth. Barometers which use **mercury** are the most common. The mercury will rise or fall depending on the pressure. When a big storm is approaching, the mercury will drop significantly. After the storm has passed, the mercury will rise again.

Our **atmosphere is warmed** in a way that is similar to the inside of a greenhouse. Sunlight that reaches the surface of the Earth is mostly absorbed. Materials which absorb this radiation become warmer as a result. But these materials also radiate some energy back into the atmosphere. The energy is then absorbed by water and carbon dioxide in the atmosphere. In effect, the warmth is "trapped" in the lower atmosphere, just like warmth is "trapped" inside a greenhouse. This is why our atmosphere is said to have the **greenhouse effect**.



There are four layers of the Earth's atmosphere. These layers are like separate spheres which occupy a given space above the Earth's surface. They are based on temperature differences. These layers are the troposphere, stratosphere, mesosphere, and thermosphere.

The **troposphere** is sometimes called the zone of weather, because this lowest layer of the atmosphere is where Earth's weather systems occur. It is a dense layer of air in which molecule motion fueled by sunlight provides the energy necessary for weather to occur. In the troposphere, temperatures decrease with increasing altitude. For instance, it would be very cold at the top of Mt. Everest (the highest point on Earth's surface), and very hot at Death Valley (the lowest point in the United States).



The higher up you go, the thinner the atmosphere.

Above the troposphere is the **stratosphere.** Here, the temperatures increase with increasing altitude. This layer has become very important for scientists to observe, since it contains the ozone layer. The **ozone layer** filters harmful ultraviolet radiation from the sun. Recently, scientists have discovered holes in the ozone layer and believe that they may be caused by industrial gases. Like the troposphere, the air molecules of the stratosphere appear to be frequently colliding as the different gases mix. This produces a heavier layer of air with higher pressure.

Next in altitude is the layer of atmosphere called the **mesosphere.** Temperatures in this layer go back to the pattern of the troposphere, where temperatures decrease with increasing altitude. Finally, the **thermosphere** surrounds the mesosphere. Temperatures here increase with increasing altitude. Charged particles make up this layer which is sometimes called the **ionosphere**. These top two layers of atmosphere are less dense than the lower two layers. For this reason, the molecules are widely-spaced and generally lighter, with less pressure.

PRACTICE

1. If you heard a weather report state that the barometer was falling, what would you suppose it meant?

2. Why is the air "thinner" at the highest reaches of our atmosphere?

3. Why is the air pressure heavier closer to the surface of the Earth?

4. If air is invisible, how do you know it is present?

5. What place on Earth would be hottest—the air at the top of a mountain, or the air at the bottom of a valley? Why?

6. Which layers of the atmosphere have the highest pressure and why?

7. Why is the troposphere sometimes called the zone of weather?

8. Why is the ozone layer of the stratosphere important for scientists to study?

9. Describe the mesosphere and thermosphere.

10. What causes your ears to "pop" when you take off in an airplane?

11. Why do planes try to fly at high altitudes rather than lower altitudes?

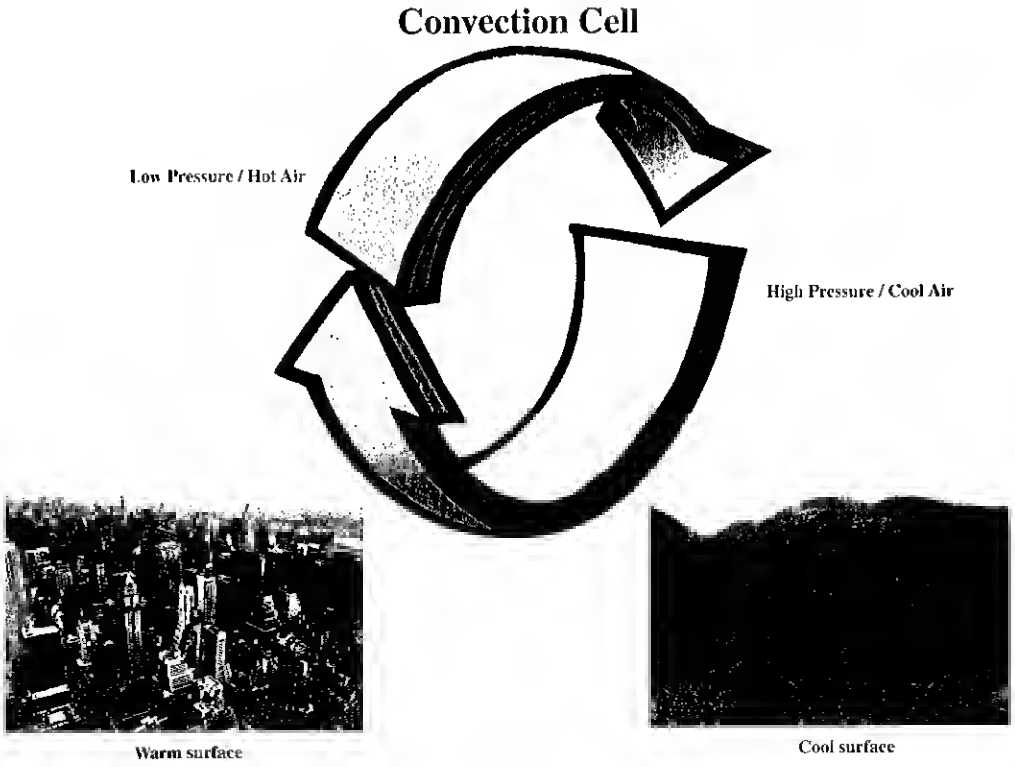
12. Why is our atmosphere said to have a greenhouse effect?

CONVECTION SYSTEMS

The air around you is constantly moving. Even when you think the air is perfectly still, it is not. Tiny molecules of gases are moving around even when the air seems calm. Other times, you know that the air is moving fast. A strong storm can make trees seem to dance in the air. This movement of air is called **wind**.

Wind is sometimes easy to see.

Have you ever walked into a basement and felt cold? Even on a summer day, basements seem cold compared to the rest of a house. This is because **cold air moves downward.** The basement would be a great place to stay during the summer, but not during the winter! During colder months, you would want to go upstairs. **Warm air rises**, and the highest part of your home will always be the warmest.



The scientific explanation for this is that air expands as it is warmed. In other words, the molecules scatter and become active. Cooler air does the opposite. It becomes denser and less active, therefore losing energy. When cool air meets warm air, the denser, cool air will flow beneath the warm air, forcing the warm air upward.

When the Earth **absorbs the sun's radiation**, some parts of the Earth get hotter than others. Some places, like **city streets**, absorb a lot of energy. You can see the radiation coming up from the street on a hot day. On the other hand, other places do not warm up nearly as much. **Forests** remain relatively cool when compared to the city streets.

As the cooler, denser air moves from an area of high pressure to low pressure (the forests to the streets), it pushes the warm, less dense air upward. This process of warmer air being pushed upward is called **convection**.

When the warmer air rises and circles back down on the cooler surface, then a **convection cell** has formed. This movement of air in a convection cell creates wind.

PRACTICE

1. Why is warm air less dense than cold air?

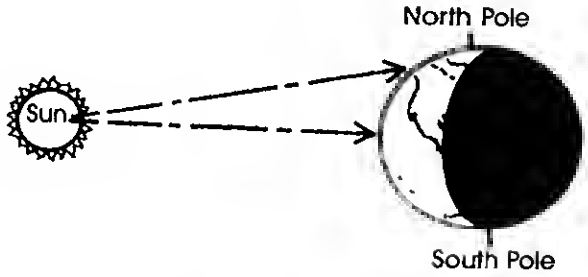
2. It is a cold winter day. You are in a three-story house. Where would you want to stay to get maximum warmth? Why?

3. Why is air pressure lower in warm air than in cold air?

4. Explain how wind is created by convection cells.

GLOBAL CONVECTION SYSTEMS

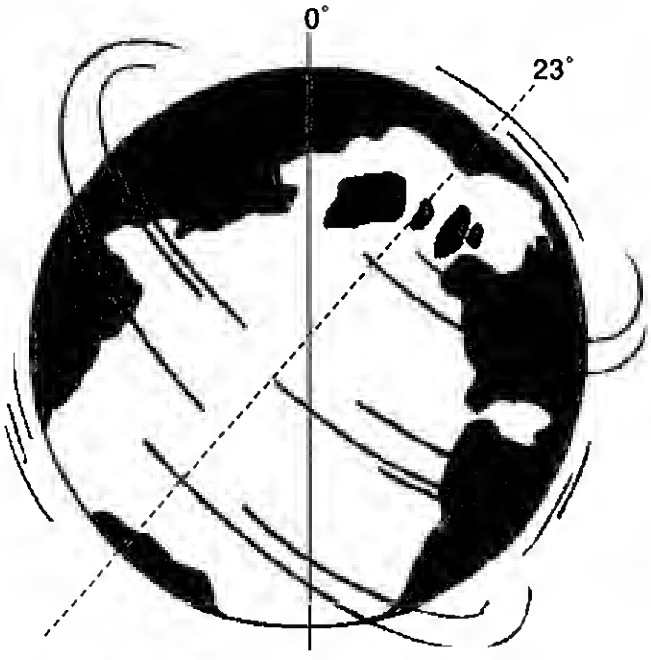
Convection cells form all over the Earth all of the time. Because of the differences in temperatures over the Earth, there are many different types of convection cells. For instance, the equator receives more direct sunlight than the North or South Pole. Therefore, the area around the equator stays very warm year-round, while the poles are cold.



The area around the equator produces warm air currents because of its direct sunlight.

You would expect a large convection cell to form as the cooler, denser air from the poles forces the warmer air from the equator upward and back towards the poles. In addition, you would expect to find an area of lower pressure at the equator and higher pressure at the poles. If it were this simple, then the wind on the surface of the Earth would always blow from the north to the south in our Northern Hemisphere. In the Southern Hemisphere, this would be reversed. But does this really happen? The answer is no. The Earth's weather is not that simple.

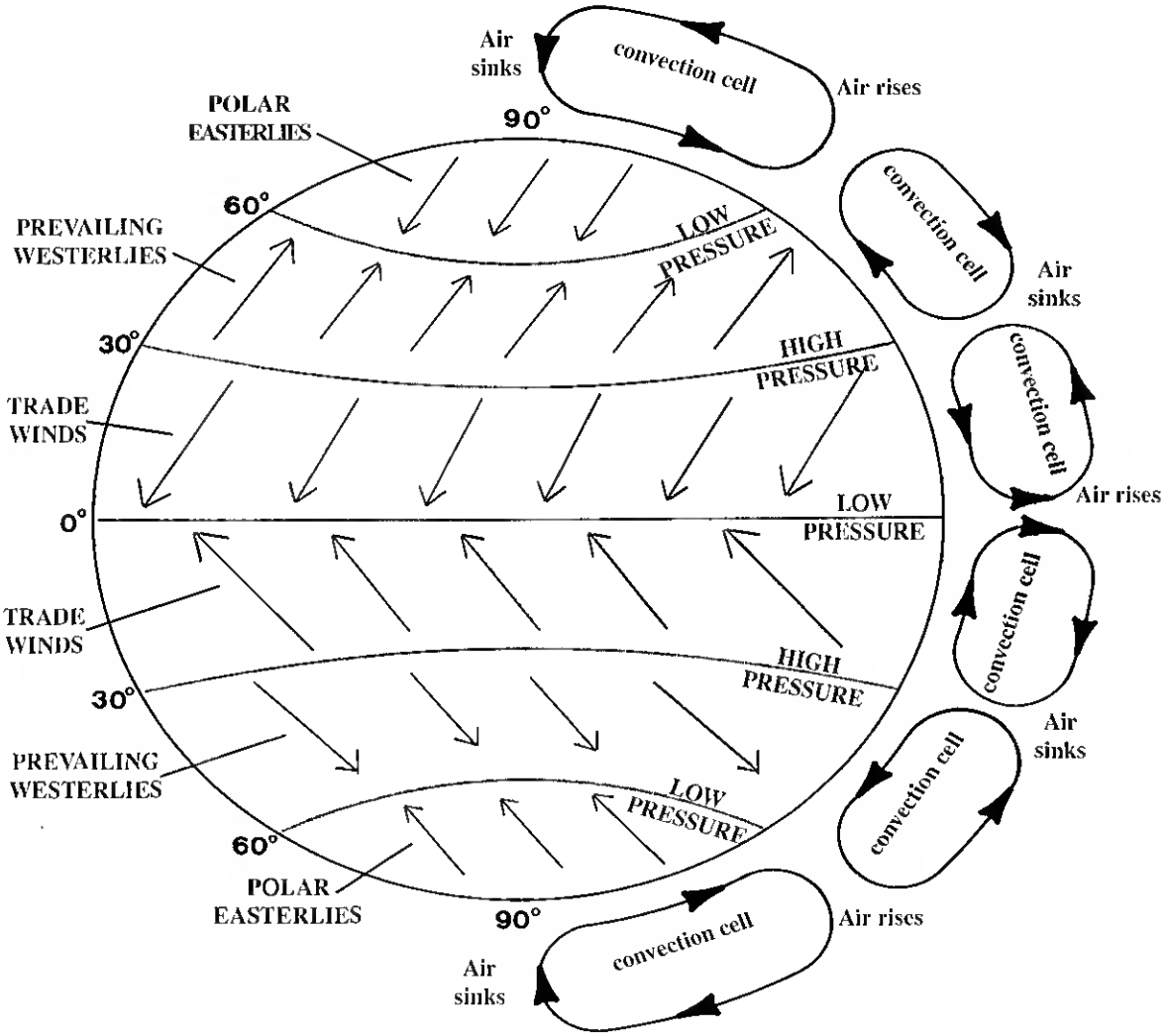
You know that the wind does not always blow from one direction. The main reason for this is that the **Earth is not still**. It is **constantly spinning** on its axis. This rotation has an important impact on the global movements of air. Basically, moving objects, including wind, in both hemispheres will curve in the opposite direction of the spinning Earth.



The Earth sits on a 23 degree tilt.

Therefore, an object passing over the United States from the North Pole to the equator will veer off in the direction of the Pacific Ocean. An object passing over South America from the South Pole to the equator will also veer off in the direction of the Pacific Ocean. This apparent turning of objects moving in straight lines is called **the Coriolis effect.** The Coriolis effect affects moving objects and the direction of winds.

The Coriolis Effect and Global Wind Patterns



Air is heated at the equator, becomes less dense, and moves toward the poles. This forms a low-pressure band around the equator. As the poleward moving air gets to about 10° latitude, the Coriolis effect starts to occur. In the latitudes starting from the equator to 10°, there is little air movement. For sailors long ago, these were called the **horse latitudes.** To lighten their heavy ships so that the ships would sail faster in less wind, horses and other heavy items were sometimes thrown overboard.

By the time the air moving towards the poles reaches a 30° latitude, it tends to sink back to Earth. This piling up of air forms a warm high-pressure zone. Air moving away from the high-pressure zone produces two global wind belts, the **trade winds** and the **prevailing westerlies**. These wind belts are near the surface. Some of the upper air continues on to the poles. Over the poles, it sinks again to the surface. Then it moves back toward the equator. This produces a third global wind belt called the **polar easterlies**. Study the diagram of the Coriolis effect and these global wind patterns.

PRACTICE

1. Why is the equator warmer than the poles?

2. Describe the Coriolis effect.

3. In a straight line flight from Chicago to New Orleans, where would you land? Why?

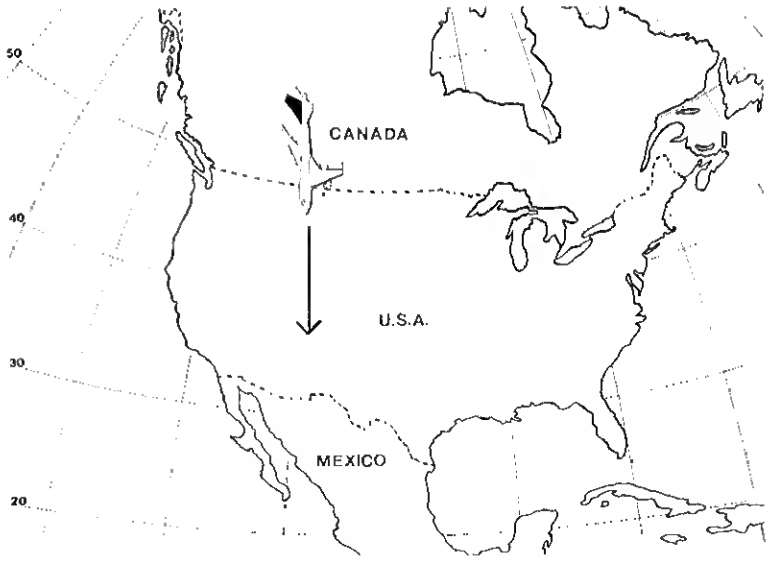
4. Using the diagram of the Coriolis effect, explain why much of the United States would be a "battle zone" of air masses.

5. What are the horse latitudes?

6. What causes the direction of the wind?

7. Why does the equator stay warm year-round while the North and South Poles are cold year-round?

8. Imagine a plane flying due south from Canada to Mexico. According to the Coriolis effect, in what direction will the plane ACTUALLY drift? Why?



9. Name and describe the three global wind patterns.

1.

2.

3.

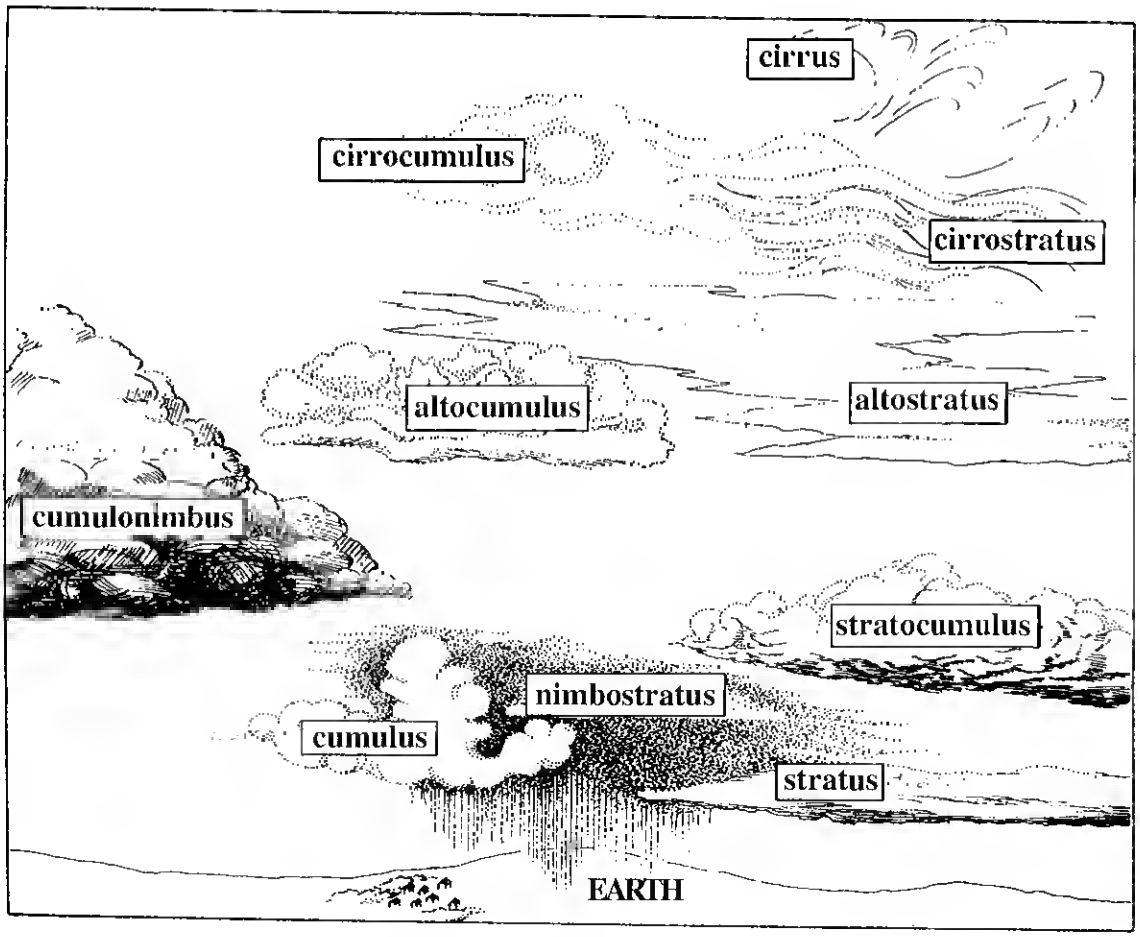
CLOUDS

Clouds are made up of millions of **small droplets of water**. The water droplets have been condensed on tiny particles like smoke, salt, and dust present in the atmosphere. Once the water vapor sticks to these particles, the droplets get larger and larger in size. But, a cloud droplet is still very small compared to a raindrop.

Clouds must have **three things** in order to form. First, there must be **water vapor** present in the air. Next, there must be **cooling** in the atmosphere. Without cooling, the air will not reach the dew point. Finally, once the air has cooled, **condensation** will occur and a cloud will form. (Remember, clouds are part of the water cycle.)

There are many different types of clouds. They are named for their shapes and for the height at which they occur. The three basic shapes of clouds are **cumulus**, meaning "piled up," **stratus**, meaning "spread out," and **cirrus**, meaning "hair-like strands." There are different combinations of clouds, as seen in the picture below.

Types of Clouds



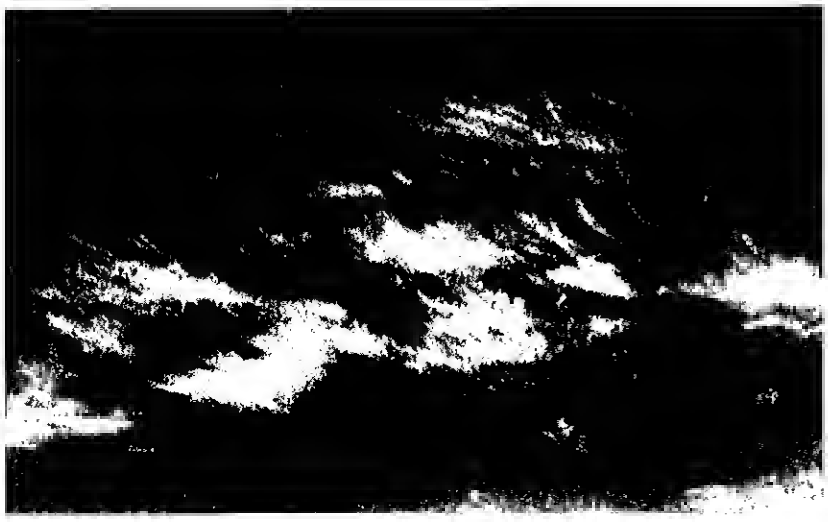
Cumulus clouds form when moist air collects rapidly over a small area. The moisture will pile up and form cumulus clouds. You can see these clearly. Sometimes, the pile of clouds gets so high that it creates a storm cloud. These clouds are called **cumulonimbus** clouds, and will always cause thunderstorms accompanied by hail, heavy rain, lightning, and perhaps tornadoes. **Altocumulus** and **cirrocumulus** clouds occur at higher elevations, but retain their "puffy" appearance.

Cumulonimbus clouds cause thunderstorms.

Stratus clouds are spread out over the sky.

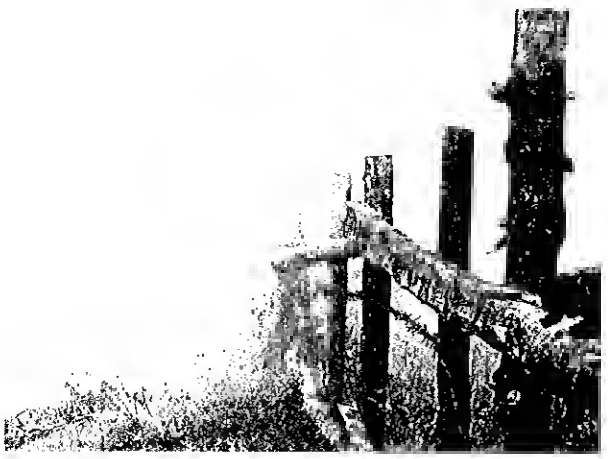
Stratus clouds form as air rises gently over a very large area and then cools slowly. These clouds are not piled up, but are **spread out** over the sky. If the stratus clouds are 2-7 km above the Earth's surface, they are called **altostratus** clouds. They make the sunlight seem filtered. Even higher stratus clouds are called **cirrostratus** clouds. They occur at altitudes above 7 km. They consist of tiny ice particles, and may cause the sun or moon to appear to have a halo surrounding it. **Stratocumulus** clouds are puffy clouds that are stretched out across the sky. **Nimbostratus** clouds are storm clouds that are spread out over a large area in the sky.

Cirrus clouds are the highest in the atmosphere. These form when water vapor condenses directly into ice crystals. These types of clouds sometimes appear as ringlets of hair high above the Earth. Other times, they look like **wispy feathers.**



Cirrus clouds look like wispy feathers.

Fog is also a type of cloud. Fog occurs close to the surface of the Earth. It consists of very small water droplets that fall to Earth very slowly. Fog is like a cloud that has sunk to the Earth. Coastal fogs are common and occur when the moisture from the ocean carries over onto cooler land masses. Fog will also settle in low-lying areas. If for example, you lived in a valley, fog would be worse there than it would be at higher elevations.



Fog can cause serious problems when you have to drive.

PRACTICE

1. What is the difference between a cloud and fog?

2. What three things does it take for a cloud to form?

   1.

   2.

   3.

3. Where are fogs ***most likely*** to form, and why?

4. Which types of clouds would signal dangerous weather, and why?

5. Sketch the three major types of clouds in the graph below.

Name	Description	Sketch

WEATHER CONDITIONS

Air Masses

In a previous section, you learned about the **movement of air** in the Earth's atmosphere. In the Northern Hemisphere, there are two large areas of high pressure. In both of these areas, air piles up, sinks, and then spreads out slowly across the surface. As the air moves across the surface, it takes on the temperature and the moist or dry conditions of the surface below. Such large areas of air with the same temperature and moisture levels of the surface are referred to as **air masses.**

Air masses can be very large, maybe even thousands of square kilometers, but are only a few kilometers deep. Air masses move like **giant air bubbles**. They may move very slowly as pressure builds. As an air mass moves over your part of the Earth, you experience the conditions of the air mass itself. A **cold air mass** will produce cooler weather and you may need a coat, while a **warm air mass** will bring warmer temperatures.

Air masses are classified according to their **temperature** and **moisture (absolute humidity) content.** They get their characteristic names from the **source regions** over which they are born. The temperature characteristics are defined by **Arctic, Antarctic Polar, Equatorial,** and **Tropical**. The moisture content is defined by Maritime and Continental. A **Maritime** air mass is a moist air mass that forms over the oceans, and a **Continental** air mass is a dry air mass forming over the continents. The temperature and moisture terms are combined to describe the air mass.

Air masses can be designated as hot or cold, wet or dry. There are four combinations: hot and dry; hot and wet; cold and wet; and cold and dry. There are also two additional temperature categories, "very hot" and "frigid" air masses, for those forming over the equator and polar regions. **Wet air masses** are air masses that form over the oceans, and **dry air masses** form over the continents. **Equatorial air masses** are considered to be wet because much of the land area under the equatorial zone is covered in tropical rainforests that can add as much moisture to the air as the equatorial oceans. All **Arctic or Antarctic air masses** are considered dry because there is little evaporation into them from the frigid polar oceans, and their temperatures are so low that the absolute humidity is very low.

Air masses acquire the properties of the terrain over which they move. Cold Arctic air masses are in the Arctic regions, and Maritime air masses form over water. Air masses move, and a Maritime air mass that moves over land will lose its moisture and become continental. Tropical air masses that move north will cool down and become polar or Arctic. Continental Polar air warms when moving south.

Air Mass Classification

(Letters are used to label air masses on weather maps.)

Moisture:	Temperature:
m for maritime	A for Arctic
c for continental	P for polar
	T for tropical
	E for equatorial
	AA for Antarctic

Global Air Masses:

(cA) Continental Arctic—very cold, formed over poles; very dry due to extreme cold

(cAA) Continental Antarctic—very cold, formed over poles; very dry due to extreme cold

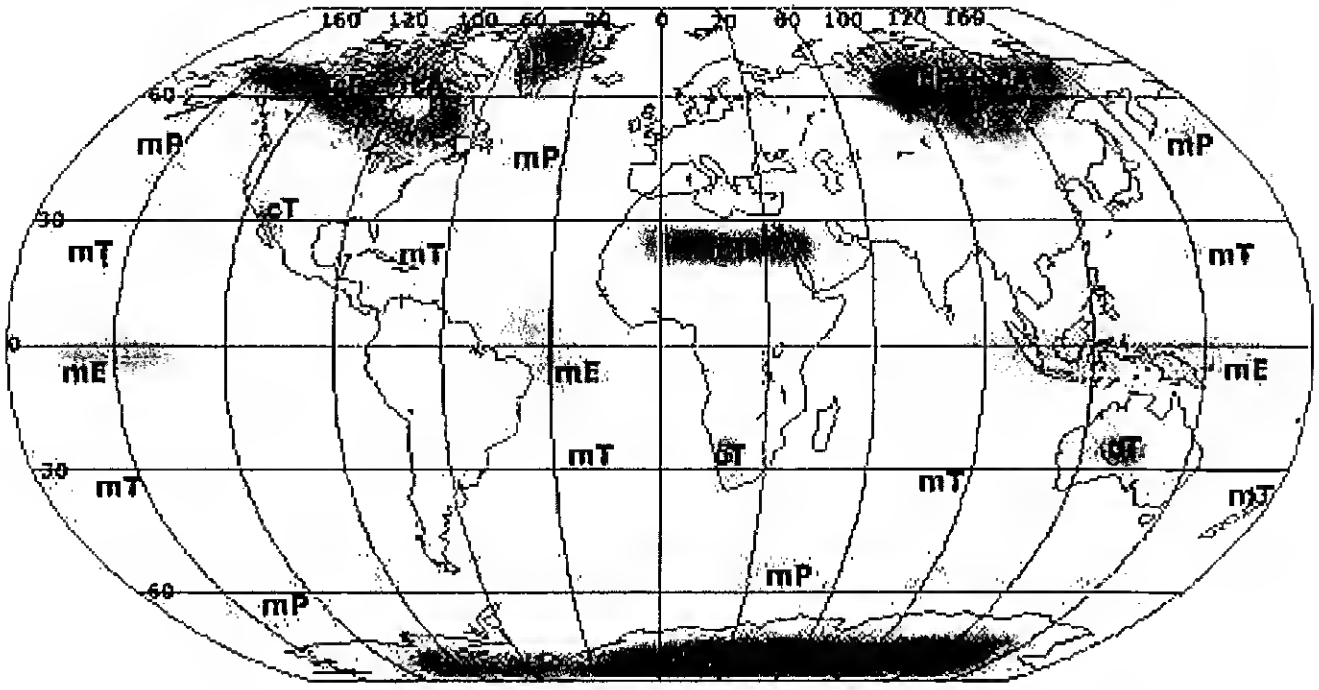
(cP) Continental Polar—very cold having developed over sub-polar regions; very dry due to the cold and having developed over land

(cT) Continental Tropical—very warm because of the lower sub-tropical latitude of formation; dry because it formed over land

(mT) Maritime Tropical—very warm because of the sub-tropical latitudes at which it formed; very humid because of the warm tropical waters below

(mE) Maritime Equatorial—hot; extremely humid

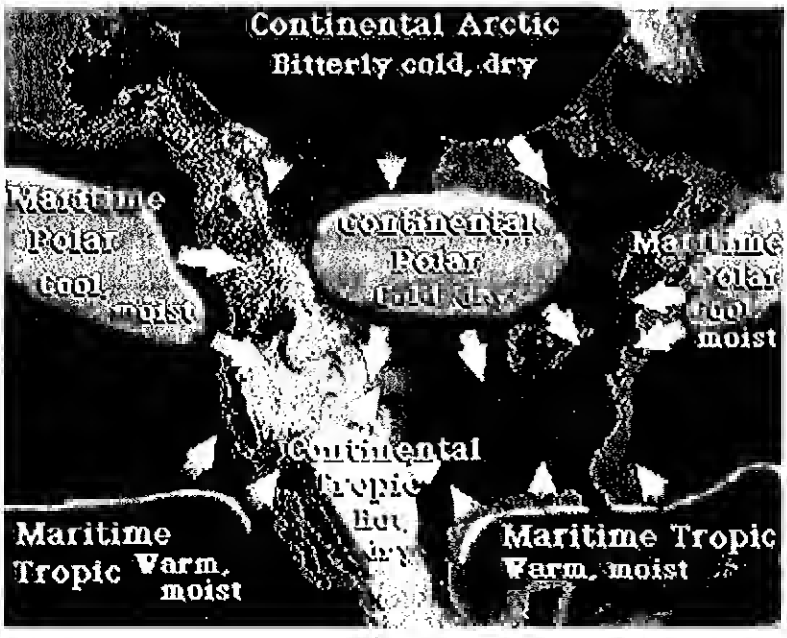
(mP) Maritime Polar—very cool because of the high latitude but not cold, due to the influence of the sea and the warm ocean currents at these latitudes; moderately moist because of the cool temperature, but not as dry as polar continental air because of evaporation from the water surface



Global Air Masses

Air Masses Affecting North America

The **temperature** of a place depends on the **source of the air mass** and the **path of the air mass** as it moves from its source region. If an air mass is located in the middle of an air mass source region, climate will be fairly uniform throughout the year. For example, if you lived in the north central part of Canada, you would be in the middle of the Continental Polar air mass (cP). Temperatures there would be cool to cold, and the humidity would be low throughout the year. But, if you lived in Illinois, you would have a greater difference in temperature because Illinois is in the boundary zone between several different air masses. The Continental Polar (cP) and the Maritime Tropical (mT) air masses influence this area. The cP air mass brings cool, dry weather while the mT air mass brings humid and warm conditions. When these air masses collide, storms are produced.



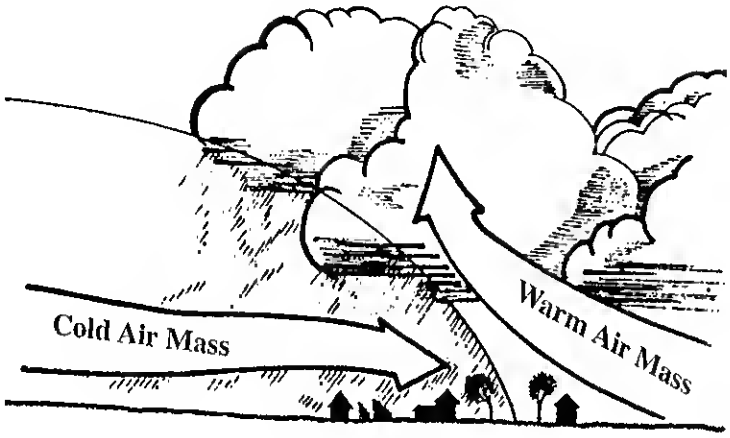
North American Air Mass Source Regions

It is the movement of air masses that creates the **system of atmospheric changes** that we call **weather**.

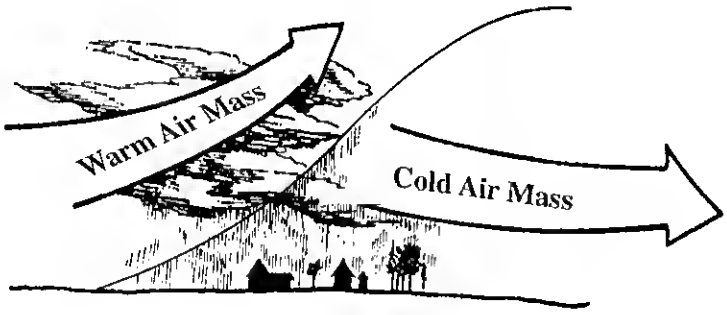
Weather depends on three conditions:

1. The temperature and moisture level of the air mass.
2. The temperature and moisture level of the surface.
3. The speed of the air mass.

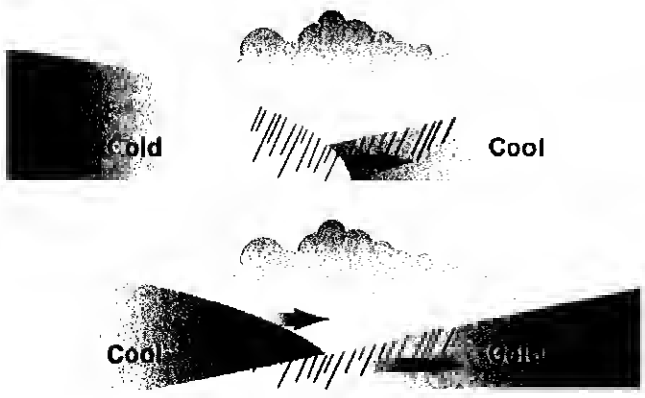
Because air masses are so large, it may take several days for one to move to another location. In the process, some air masses overlap others as they move. The leading edge of a moving air mass is called a **front**. A **cold front** occurs at the edge of a cold air mass. Cold air moves under a warm air mass and causes the warm air mass to rise. Cold fronts bring snow, thunderstorms, and heavy rain. A **warm front** occurs at the edge of a warm air mass. The warm air mass moves up over a cold air mass, replacing the cold air mass. Warm fronts bring rainy weather followed by warm, clear weather. If air masses are not moving, then the space between the masses is called a **stationary front**. A stationary front brings days of overcast, rainy weather. An **occluded front** occurs when two cold air masses move toward each other, and warmer air is pushed upward. An occluded front brings cool temperatures with rain or snow.



Cold Front



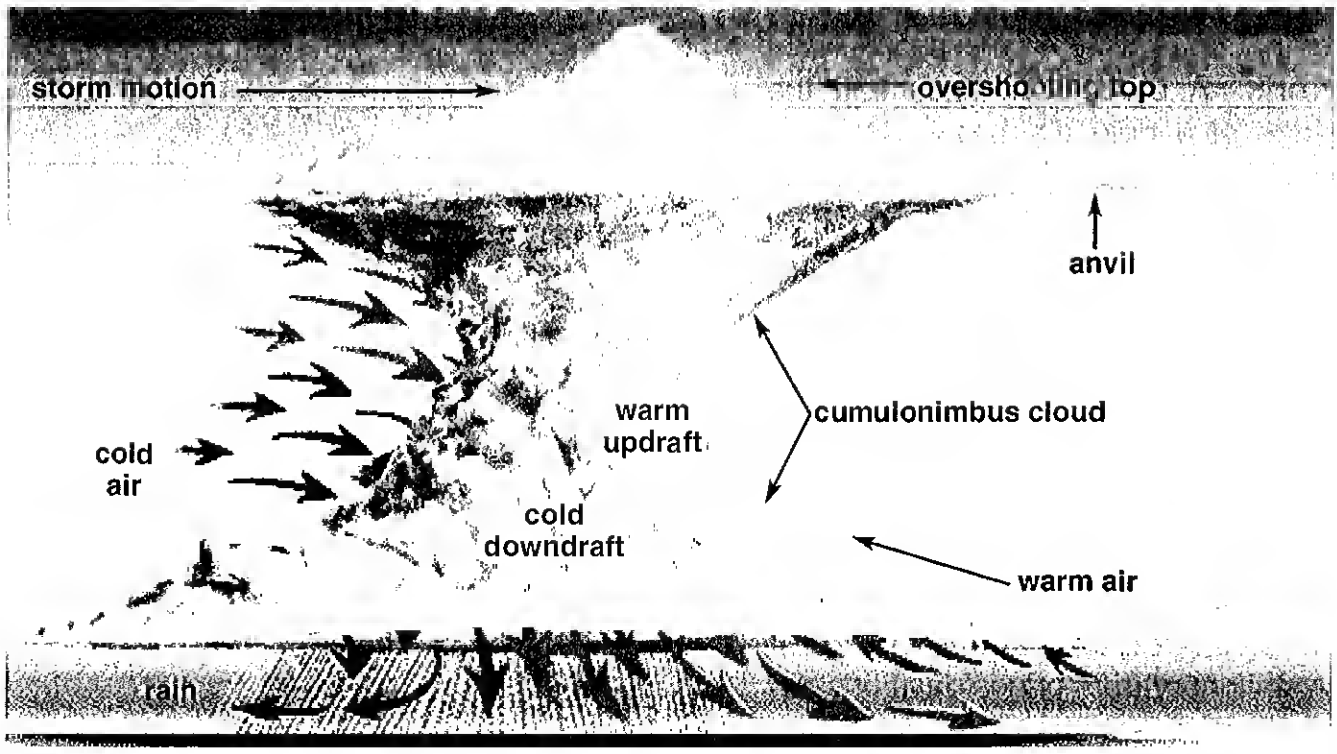
Warm Front



Occluded Front

The weather in a **low pressure** area is usually cloudy and rainy. This is because lower pressures are formed from upward moving air, such as when a cold front sweeps in underneath a warm front. The upward movement of air causes it to cool and form clouds which may result in precipitation. Rapid changes brought on by a low-pressure area are called **storms.** Three violent kinds of storms are thunderstorms, tornadoes, and hurricanes.

Thunderstorms are very intense rainstorms with thunder, lightning, strong winds, and sometimes hail. In a thunderstorm, warm air is lifted up and cooled, and the water vapor condenses into raindrops and/or hail. Wind, hail, and lightning can all cause great damage to the surface of the Earth. **Lightning** occurs as an electrical spark is generated between clouds, from a cloud to the ground, or from the ground to a cloud. It produces a pressure wave through the air which we hear as thunder.

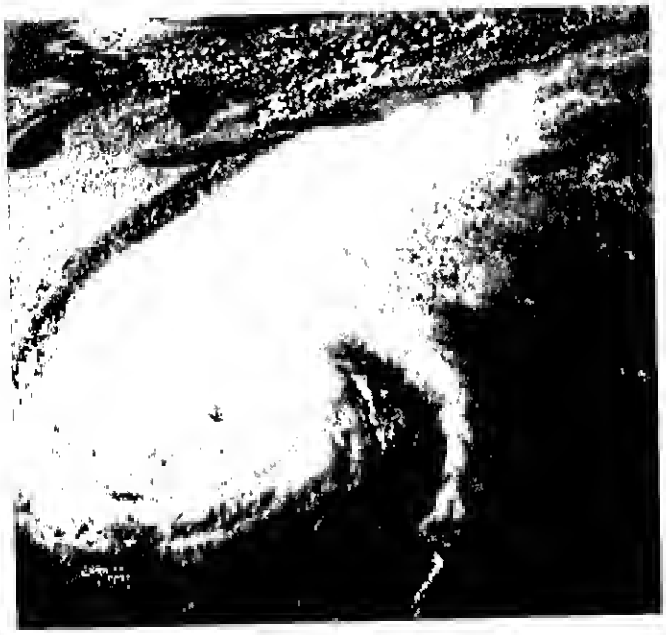


Thundercloud formation

A **tornado** is an extremely violent storm. It consists of a funnel or rope-shaped cloud which hangs below a cumulonimbus cloud. This small, low pressure area can reach speeds of up to 650 km/h or more. Its winds will sweep up anything in its path, acting like

a giant suction. Tornado winds usually move in a northeasterly direction, and are frequent in the Midwestern and Southern states, such as Kansas, Texas, Oklahoma, and Mississippi. North Carolina usually has several outbreaks of tornadoes during a year.

Tornadoes are recognized by their shape.



Hurricane Floyd, 1999

Finally, a **hurricane** is a large, violent storm created over water. Because these storms begin in warm, tropical waters during the late summer months, we are much more familiar with them in North Carolina. Large systems of cumulonimbus clouds hanging over these waters are "fed" by the movement of warm, moist air from the tropical waters. Wind speeds in a hurricane can range from 120 to 320 km/hr. The winds move in a counterclockwise fashion, forming an eye in the center. There is little wind in the eye of the storm, but after the eye passes over an area, the full wind speeds begin again.

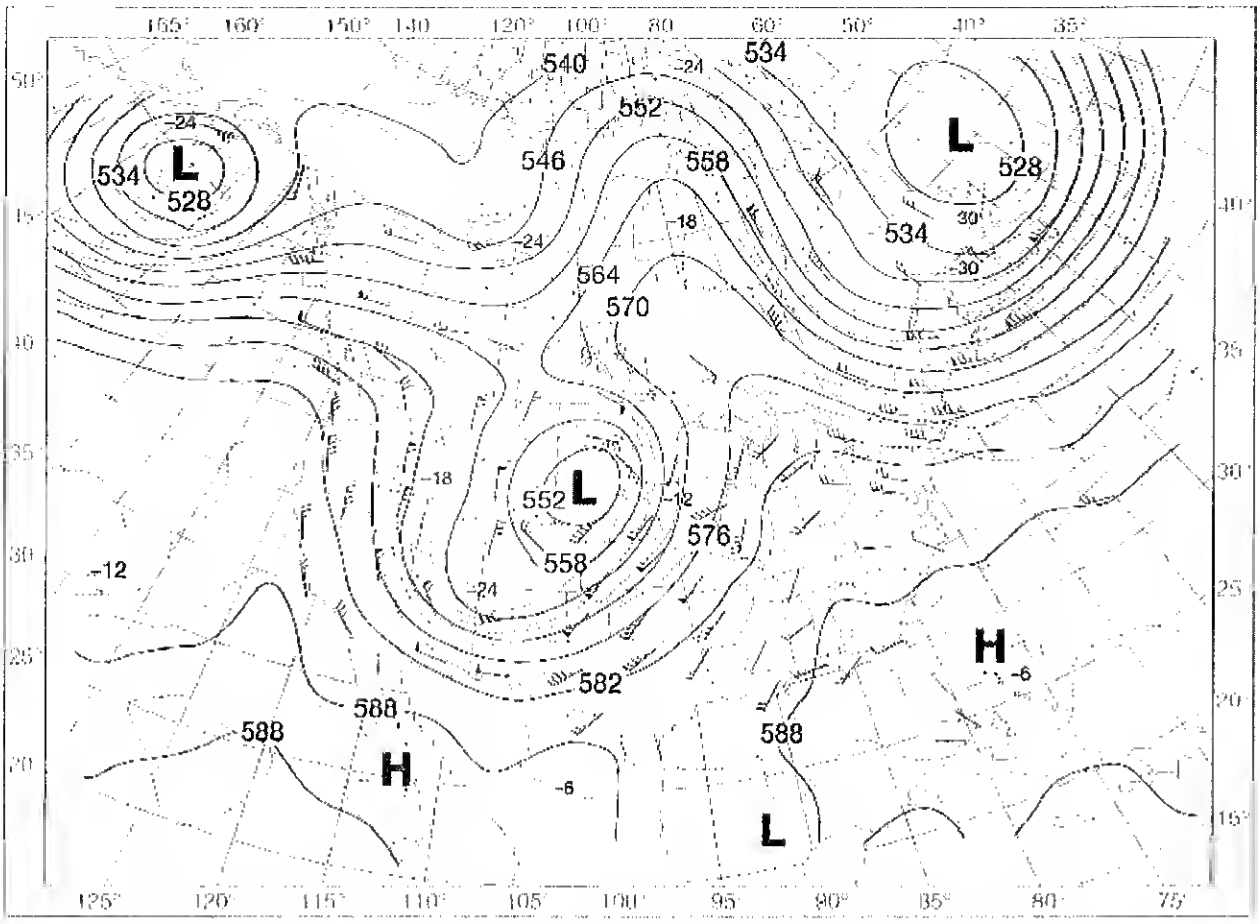
Most of the damage from hurricanes comes from the wind, heavy rain, and flooding. The strong winds cause the water levels to rise along the coast. Coastal homes are normally built up eight feet or more from the ground below, so that the home will not be damaged if there is slight flooding. However, huge areas along the coast can be flooded if storm waves are high enough. This leads to massive evacuations of people who live along the coast. The coastal plain of North Carolina was severely damaged back in 1999 with **Hurricane Floyd,** a hurricane that caused severe flooding.

Most hurricanes that originate in the Caribbean Sea take a northeasterly path along the eastern coast. This is because of the Gulf Stream current, a strong, warm ocean current that travels up the east coast and goes all the way to Great Britain. Because of the

Gulf Stream and because the coasts of North Carolina and South Carolina jut out into the Atlantic Ocean, we are in a prime location to be touched by a moving hurricane. Other times, a storm will move into the Gulf of Mexico. If this is the case, then the storm will likely hit land along the Florida panhandle or Louisiana as it moves in a northeastern fashion.

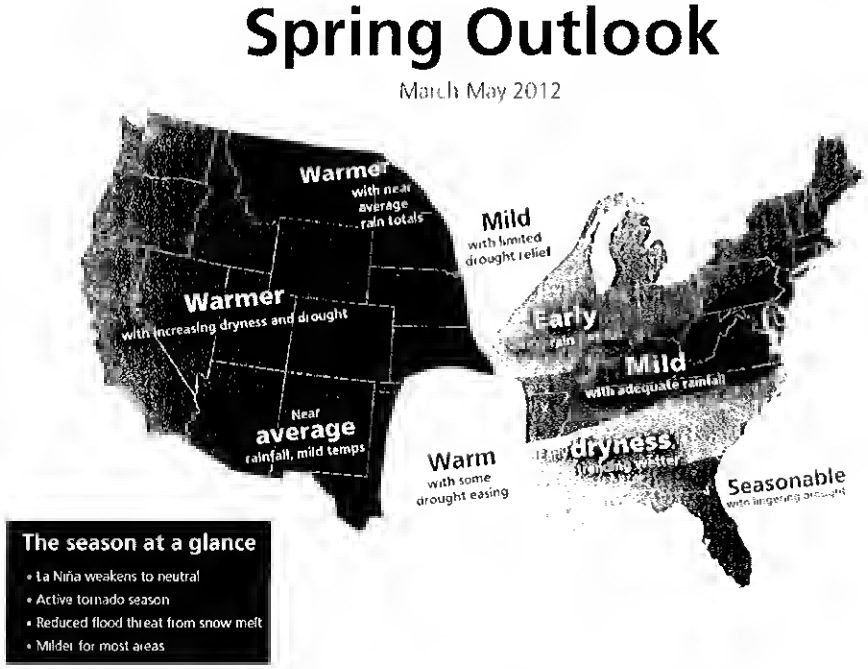
Hurricane Katrina hit Mississippi and Louisiana in August 2005. It was the worst hurricane to ever hit the United States. The winds were up to 175 mph. Over 1,800 people died because of this hurricane. Over the years, levees were built between the city of New Orleans and the ocean. A levee is an embankment of mud, rock, or sand to keep the water from flowing into the city. Katrina had so much force, the levees could not hold back the water. Over 80 billion dollars in damage happened to the areas hit by the hurricane.

Scientists who monitor weather conditions, called **meteorologists**, keep track of air masses. This allows them to make predictions about the weather. Meteorologists usually forecast the weather by using a **synoptic weather map**. This type of map gives a summary of the weather using various station models. Every six hours, meteorologists compare these maps and can tell how weather systems are moving. They use this information to predict what the weather will be hours later.



A synoptic weather map allows meteorologists to make predictions about the weather.

If you look at weather records in the past, you will see patterns or trends. **Statistical forecasting** is based on finding patterns or trends in weather. For example, you notice that the wind is blowing out of the northeast. You look up past records, and 80 out of 100 times when the wind was blowing out of the northeast, your weather became cloudy and much colder. What would your weather prediction be? Meteorologists base many of their predictions on this type of data.



Meteorologists find patterns or trends in weather by using statistical forecasting.

Local Weather Patterns

You are aware that weather changes daily, monthly, and seasonally. Some days are cloudier, windier, hotter or cooler than others. Months are the same. Winters are colder than summers, but some winters are warmer or cooler than winters in the past. **Weather statistics** are kept, and patterns can be found. Weather happens in a regular way, depending on what place on Earth the weather is occurring.

WEATHER CONDITIONS IN GREENSBORO, NC OVER A 5 DAY PERIOD:

Monday—Sunny, high temperature–76˚, low temperature–55˚, winds–10 mph, precipitation–none

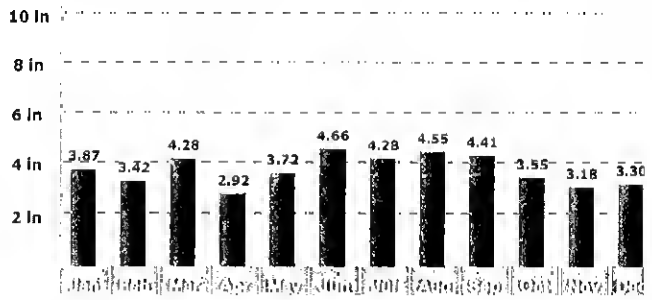
Tuesday—Sunny, high temperature–76˚, low temperature–53˚, winds–5 mph, precipitation–none

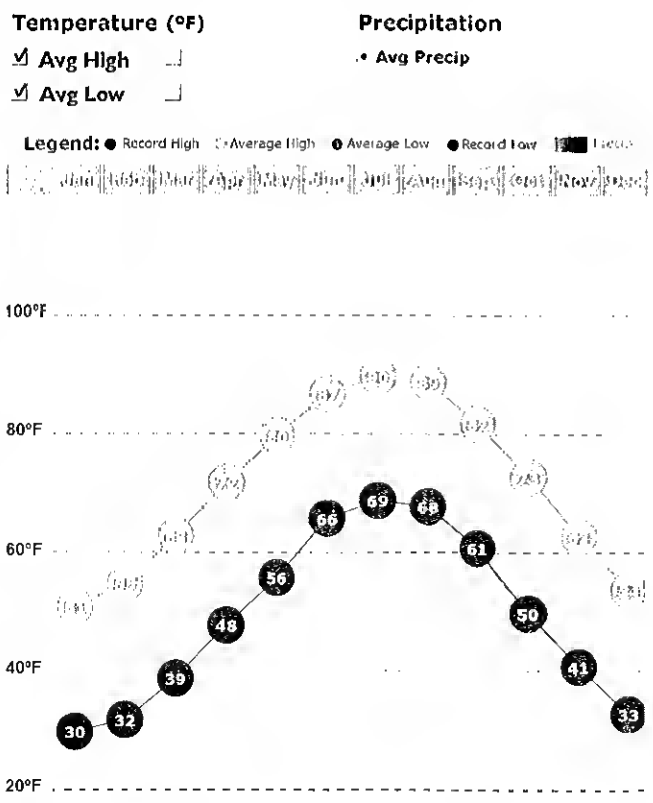
Wednesday—Cloudy, high temperature–80˚, low temperature–60˚, winds–30 mph, precipitation–thunderstorms

Thursday—Mostly cloudy, high temperature–83˚, low temperature–61˚, winds–20 mph, precipitation–drizzle

Friday—Partly cloudy, high temperature–79˚, low temperature–58˚, winds–10 mph, precipitation–none

AVERAGE MONTHLY TEMPERATURES AND PRECIPITATION FOR RALEIGH, NC





The highest recorded temperature in Raleigh was 105˚F in 1952, the lowest temperature was –8 in 1985. The coolest month is January, and the most precipitation is in June.

Seasonal North Carolina Weather

Fall—cool, some snow in the mountains, threat of hurricanes, driest month—November

Winter—moderate in central and eastern parts, cold in the mountains, snow in mountains, very little snow elsewhere

Spring—warm days, cool nights, tornadoes, thunderstorms

Summer—hot and humid, threat of tropical storms and hurricanes, thunderstorms, tornadoes, wettest month—July

PRACTICE

1. How does an air mass form?

2. How is the moisture content of an air mass defined?

3. How are the temperature characteristics of an air mass defined?

4. Explain each of the following air masses:
   a. Continental Arctic _____
   b. Continental Antarctic _____
   c. Continental Polar _____
   d. Continental Tropical _____
   e. Maritime Tropical _____
   f. Maritime Equatorial _____
   g. Maritime Polar _____

5. What three things are needed to create weather?

   1. _____

   2. _____

   3. _____

6. What types of weather are associated with low and high pressure areas?

7. How does a thunderstorm form?

8. Why is a tornado so destructive?

9. Describe the causes and effects of hurricanes.

10. How do meteorologists make weather forecasts?

11. Why is North Carolina at risk for hurricanes?

12. Why are tornadoes so dangerous?

13. What is a cold front, warm front, stationary front, and an occluded front?

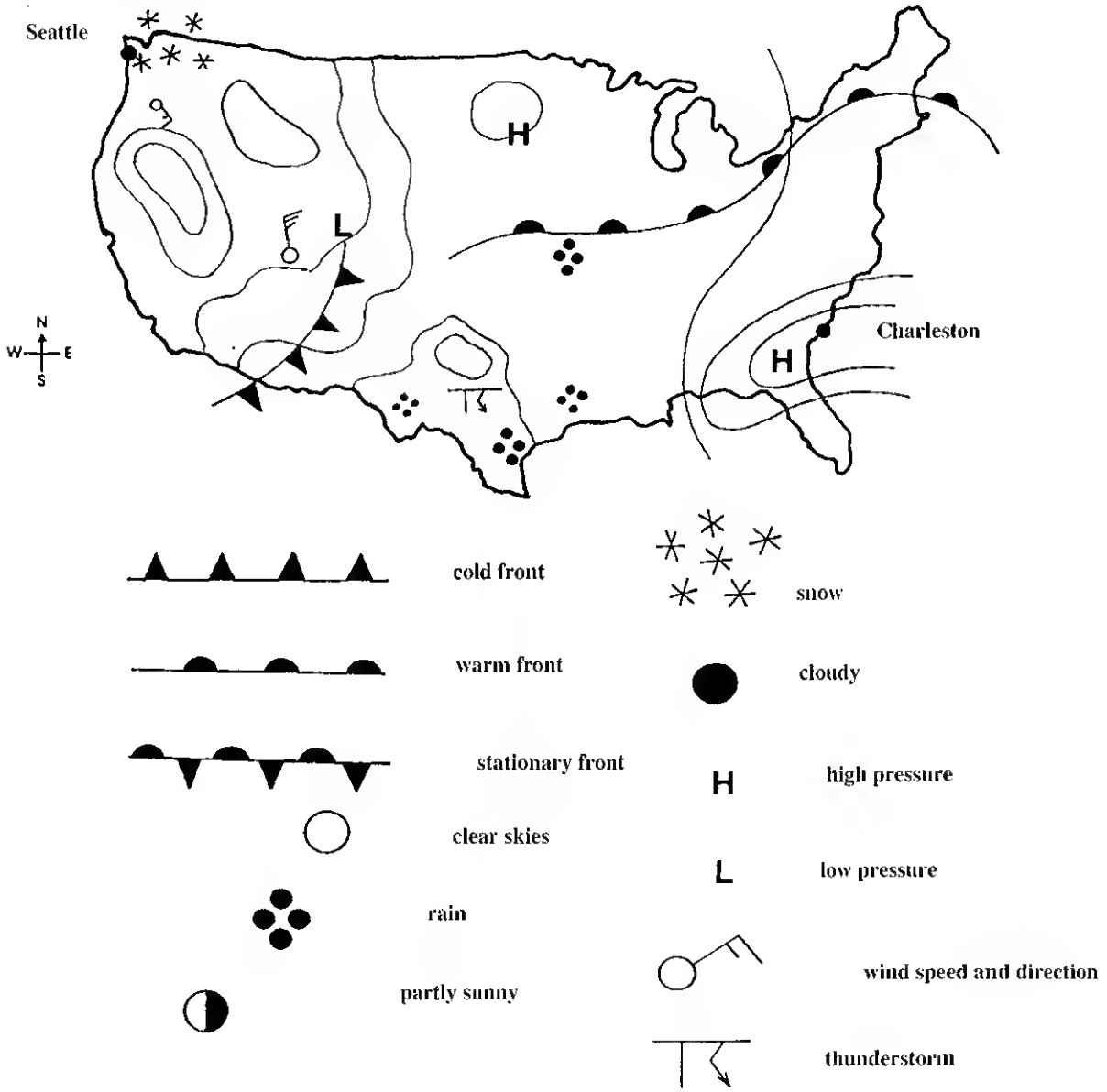
14. What kind of weather follows a cold front? A warm front? A stationary front? An occluded front?

15. Compile and use weather data to establish a climate record and reveal any trends.

16. If a city in the Northern Hemisphere has the same latitude as a city in the Southern Hemisphere, how will the seasons and seasonal temperatures compare? Explain. Give specific examples.

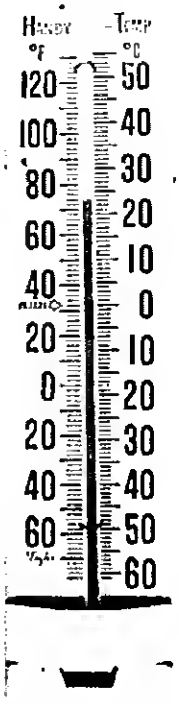
MEASURING AND PREDICTING WEATHER

Today, early warnings for severe weather are possible because of improvements in **weather forecasting**. Weather forecasting depends on sophisticated technology that gathers information from all across the nation.

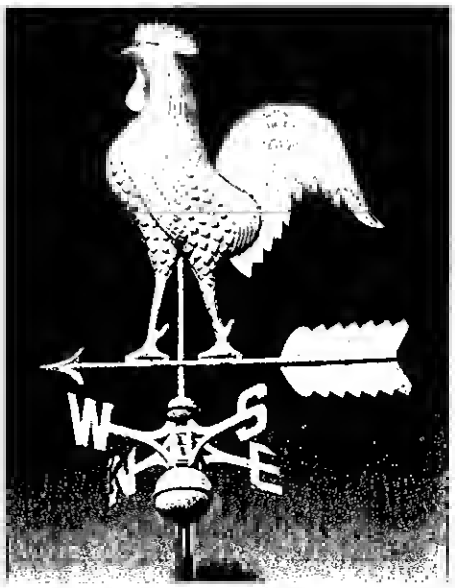


Meteorologists use different types of lines and symbols to represent a front on a **weather map**. They also use letters such as H or L to indicate high or low pressure areas across a region. If a cold air mass moved over the area where you were, then the pressure would probably go up and you would be in a high pressure area. This is because the cold air is denser than warm air. The dense, cold air sinks and spreads out. This creates clear skies and fair weather with no clouds or rain.

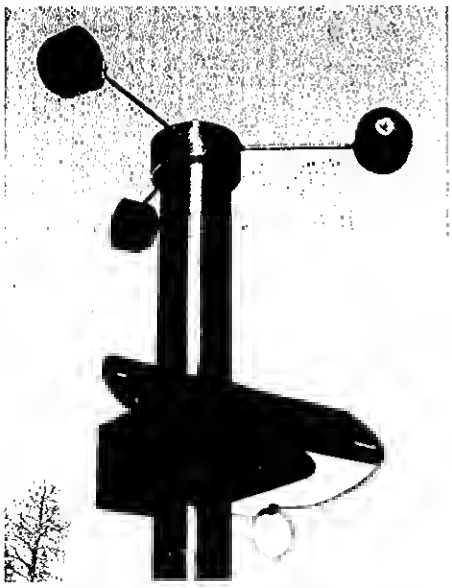
Instruments can measure temperature, relative humidity, pressure, wind speeds, and precipitation levels. A **thermometer** is used to measure the air temperature. Temperature is measured in Fahrenheit (US) and Celsius (rest of the world). Thermometers are made of glass tubes filled with alcohol or liquid mercury. When the air around the tube heats the liquid in the tube, the liquid expands and moves up the tube. Air pressure is measured with a **barometer**. A barometer measures the pressure of the air pushing down on a tube filled with mercury. If the pressure is rising, it means sunny, dry weather. If the pressure is falling, it means rainy weather. A **wind vane** measures the direction of the wind blowing. A wind vane has a large object with a large surface area that turns toward the wind direction. A compass on the wind vane measures the direction north, south, east, or west. The wind vane might be a sculpture of an object such as a rooster. An **anemometer** measures wind speed. The cups on the anemometer catch the wind and turn a dial on the anemometer which measures the wind speed. A **hygrometer** measures humidity which is the water vapor content of the air. A **rain guage** measures the amount of rain that falls.



What is the air temperature?



In what direction is the wind blowing?



What might this instrument measure?

Weather information collected from weather satellites and radar is sent to offices of the **National Weather Service**. Weather satellites carry instruments such as cameras to scan the Earth and give us pictures of the Earth's weather. Pictures of clouds are

taken from a satellite. You see these pictures when you watch the weather news on television. A weather satellite can be in a geostationary orbit at a high altitude. It will orbit the Earth every 24 hours. Scientists use the term **geostationary** to describe an orbit of a satellite when it appears to be in the same position because it is moving in synchrony with the Earth's rotation. The other type of satellite orbit is called **polar** because it is near the North or South Pole. It is at a low altitude and takes pictures as the Earth turns beneath it. **Radar** uses radio waves to measure the distance and location of weather such as rain.

With all of this information, meteorologists can make predictions about the weather. Their forecasts will tell you their predicted temperature and precipitation ranges. A "60% chance of rain" means that if conditions are right, then it will rain 6 times out of 10. There may still be a few areas that will not get rain, but most will. The lower the percent chance of rain the better chance for fair weather.

PRACTICE

1. A weather forecast says that tomorrow will be partly cloudy with a 40% chance of precipitation. What does this mean?

2. What weather instrument is used to measure air temperature? How does it work?

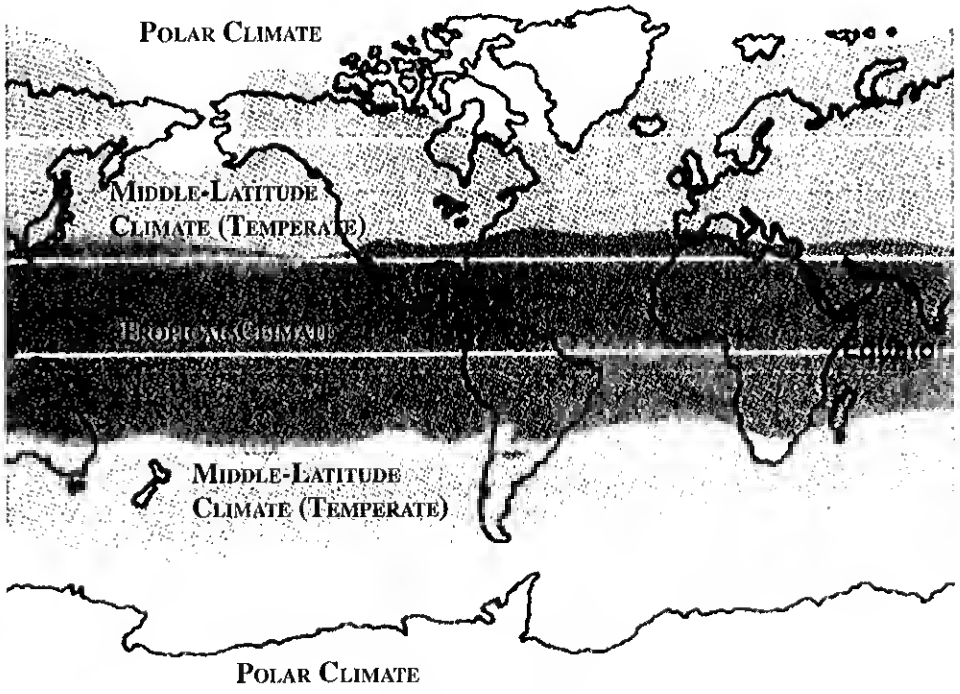
3. What weather instruments are used to measure wind? How do they work?

4. Using the map on page 146, what type of weather conditions do Seattle and Charleston have?

CLIMATE

Weather refers to the **day to day** atmospheric conditions in a certain area. **Climate** refers to the average weather conditions in a certain area **over a long period of time**. Climate, therefore, does not change as much as the weather. The two most important factors in determining climate are **temperature** and **precipitation**.

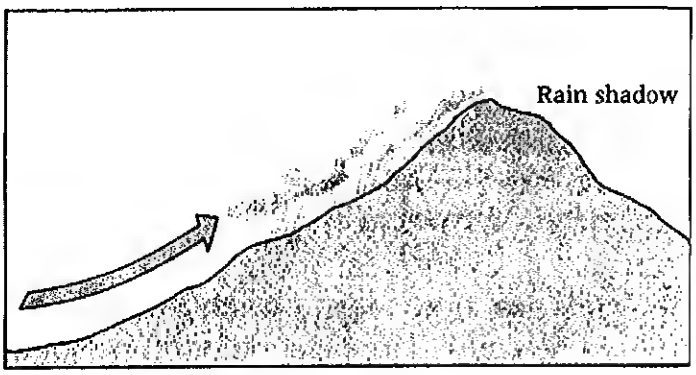
There are three major climate zones in each hemisphere. These zones are based on latitude, which is the distance north or south of the equator, and overall temperatures. The three zones are polar, temperate, and tropical. The **polar** zones are located around the North and South Poles. These zones have very cold climates. The **temperate** zones are sometimes referred to as the mid-latitudes. These zones have moderate temperatures that are neither very cold nor very hot. But there is less predictability in the temperate zone than in the other two zones in terms of temperature. The **tropical** zones have very mild temperatures year-round.



Climate Zones

Distance from the equator also determines **precipitation patterns**. Warm, moist air rises upward near the equator. It then cools and forms clouds which results in rain. Around 30° latitude, air slowly sinks. This latitude tends to be a dry zone. In fact, most of the world's deserts lie at 30° north or south of the equator. Another wet zone occurs at 60° latitude and two more dry zones occur at the poles. As the seasons change, the wet and dry zones move. This is because the angle of the sun's rays striking the Earth change as the Earth spins on its axis and revolves around the sun. This movement causes the Northern and Southern Hemispheres to have opposite seasons.

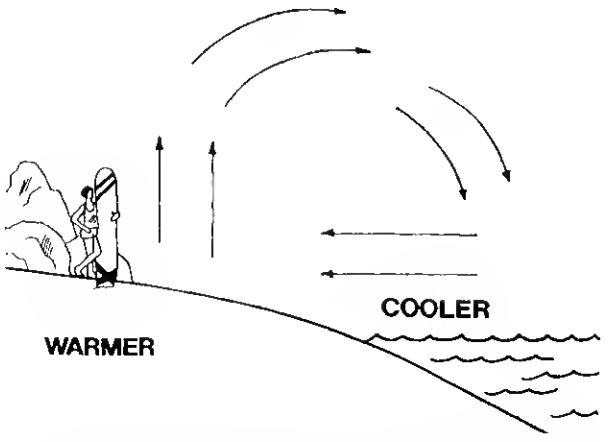
When mountains are nearby, the rainfall amounts can vary within a small distance. As moist air masses rise to the top of a mountain range or large mountain, the air cools, and the water vapor condenses as rain or snow and falls on the windward side or top of the mountain. This process is called **orographic precipitation.** This causes the leeward side of the mountain to receive the descending dry and warming air. The leeward side of the mountain will be quite arid. This area is called the **rain shadow**. Examples of this in the United States are the Cascade Mountains of Oregon and Washington and the Great Basin which covers all of Nevada and parts of Utah.



Orographic Precipitation


The Great Basin is an example of rain shadow.

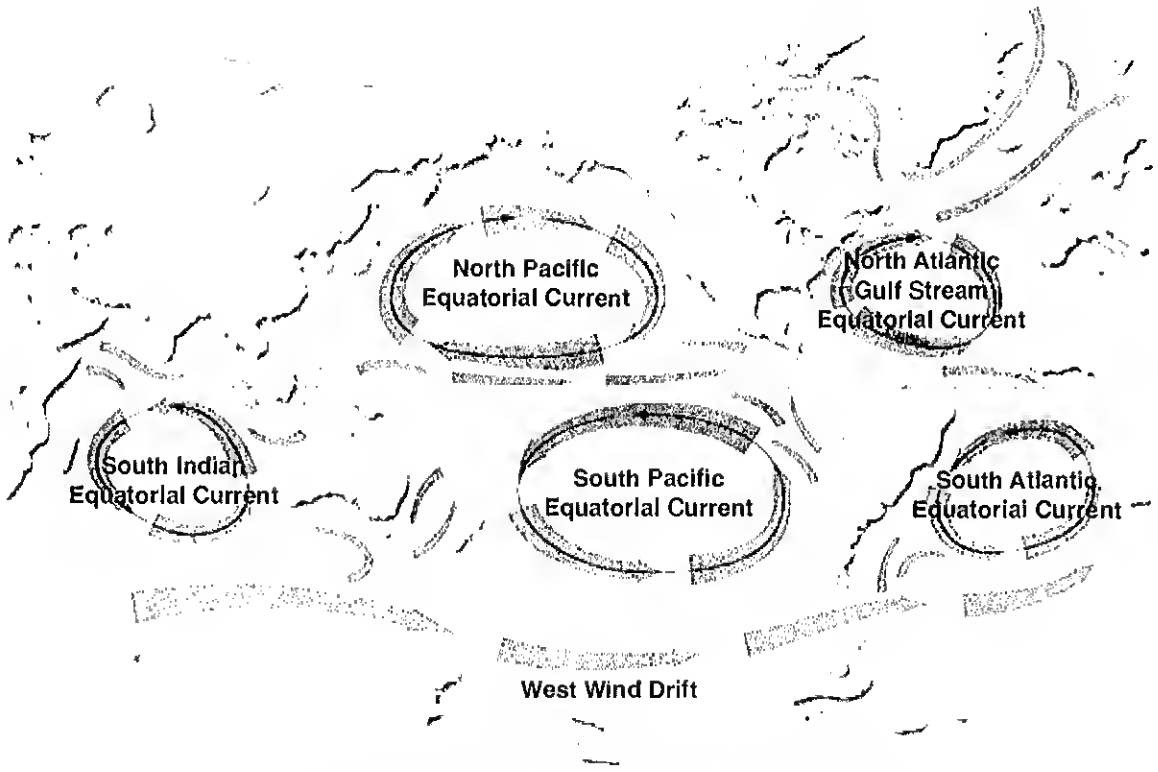
Climate is also influenced by local factors that are different for different locations. These include **large bodies of water** and **ocean currents.** The climate of a seacoast is influenced by a sea. Large bodies of water, such as seas, oceans, and lakes, increase the humidity of the atmosphere. They also affect the temperature. Even if temperatures are hot inland, near the coast, it will be cooler. You have probably noticed this if you have traveled from the inland to the coast of North Carolina during the summertime. **Sea breezes** help to keep the temperature down near the coast. These breezes are formed as cooler air descends over the water and moves toward the warmer, rising air over the land.



Sea breezes are formed as cooler air descends over water and moves toward the warmer, ascending air over the land.

Ocean currents also affect climate. When you think of the ocean you might think of one giant pool of water. It might surprise you to learn that giant rivers of water flow through the ocean. These rivers are called ocean currents. Ocean currents move more water than the largest rivers on land. There are warm water currents and cold water currents.

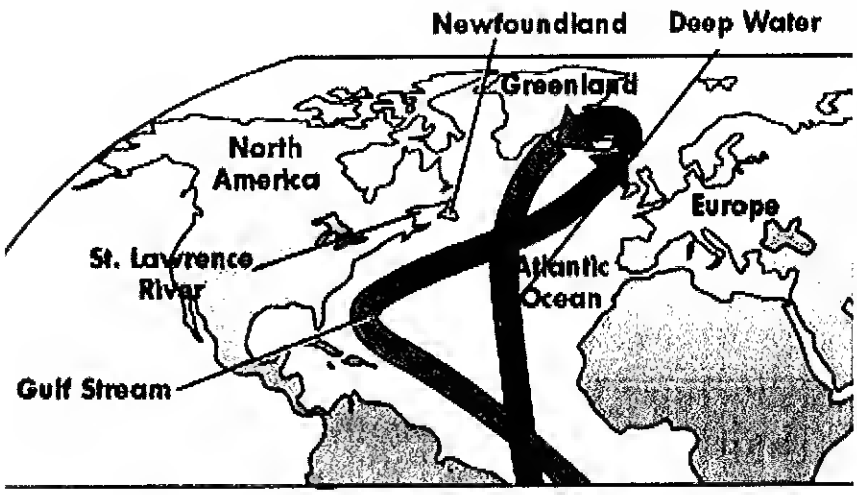
Warm ocean currents get their power from three main sources:
1. heat from the sun. 2. strong winds. 3. the spinning of the Earth on its axis.



Ocean currents are like massive rivers within water.

When water at the ocean's surface is heated by the sun, it expands, or spreads out. Steady winds push the water, making it flow. The spin of the Earth causes the water to flow in certain directions.

For example, the **Gulf Stream** brings warm ocean currents from the equator north through the Caribbean Sea and up the east coast of the United States. As a result, cities like Savannah, Charleston, and Boston are influenced by its effects. Because the Gulf Stream temperature is warm, the air mass above it will be warm as well. During the winter time, this keeps the temperatures mild along the coast compared to those inland. This



The Gulf Stream takes warm, shallow water from the tropics to the eastern coast of North America and to northwestern Europe.

is especially noticeable the farther north you go. The Gulf Stream also affects the climate of Europe. After it leaves the coast of the United States, it travels in a north-easterly direction toward Great Britain. The warm water keeps the climate of Great Britain and Western European countries mild, while the inland countries of Europe have cooler climates.

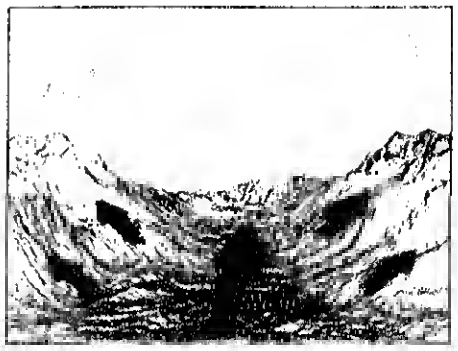
Cold ocean currents run deep below the surface of the ocean, where the water is not warmed by the sun. These cold, heavy currents creep along the bottom of the ocean until they reach the tropics. Here, as winds blow warm surface water out to sea, the cold water rises to fill in the gap.

As winds blow warm surface water out to sea, the cold water fills in the gap.

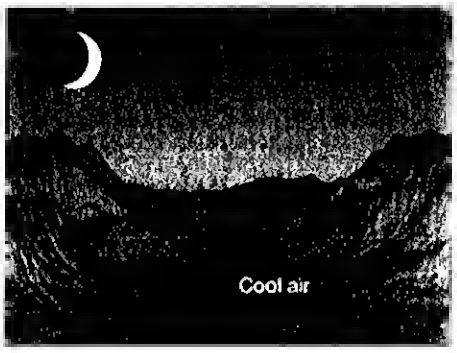
Ocean currents have a strong impact on **weather**. For example, if winds are weak, warm surface water will not be blown aside. This means cold water currents cannot rise. Instead, warm water currents spread out under the weak wind conditions, causing an **El Niño**. During an El Niño, the surface temperature of the Pacific Ocean rises. This causes changes in air movement and air temperature, resulting in severe storms in some areas and droughts in other areas.

The **jet stream** is different from the Gulf Stream. The jet stream refers to fast moving narrow zones of air in the troposphere which blow from the west to the east due to the Earth's rotation. The jet stream was first found by pilots when they were flying their airplanes. The jet stream causes our weather to change by changing a storm's direction and/or its speed. When the jet stream moves, it creates waves that are opposite to the flow of the main stream of air in the lower atmosphere. This action causes the air masses to spread out and creates areas of low pressure. Low pressure areas are the centers of most storms.

If you live near mountains, you probably experience valley breezes and mountain breezes. The air above the valleys is warmed by the sun during the day. This warm air rises and flows up the mountains creating a **valley breeze**. The mountains cool down faster than the valleys do at night because of the elevation. The cool air will sink and flow down the mountains creating a **mountain breeze.**



Valley breeze



Mountain breeze

PRACTICE

1. What is the difference between climate and weather?

_____

_____

2. What is the climate of your region like?

_____

_____

3. Why are most of the world's deserts located at 30° north or south latitude?

4. What is a sea breeze, and how does it cool the coast?

5. How does the Gulf Steam keep the temperature of the eastern coast of the U.S. mild?

6. What is the jet stream? When was it discovered?

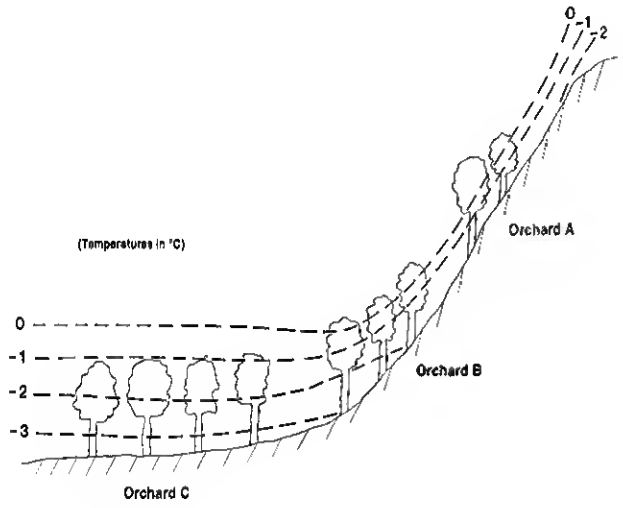
7. What is the difference between the Gulf Stream and a jet stream?

8. Explain orographic precipitation and rain shadow.

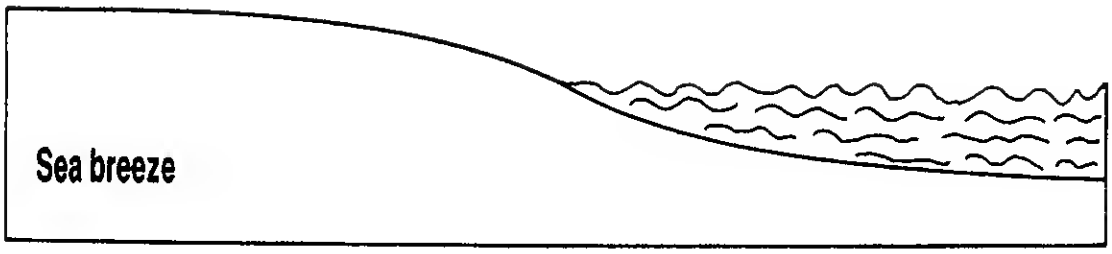
9. Explain mountain and valley breezes.

10. Oklahoma City averages 72 days a year with temperatures above 32°C. New Orleans is farther south, but averages just 57 days each year with temperatures above 32°C. What explains the difference in temperature?

11. Suppose you were growing peach trees, and you wanted to protect them against cold air. Which orchard would give you the greatest protection against cold air? Why?



12. On the diagram below, indicate the direction that a sea breeze would take.



13. What is the major cause of an El Niño?

Chapter 4 Review

1. When water droplets condense _____.
   A clouds form
   B water dries up
   C it rains
   D it snows

2. As you leave North Carolina and travel south, the temperature ***most likely*** will _____.
   A decrease
   B increase
   C stay the same
   D all of the above

3. The polar areas are cooler ***because*** they _____.
   A do not have sunlight
   B have too much sunlight
   C do not receive direct sunlight
   D have too much snow

4. Temperatures _____.
   A generally follow a pattern
   B are not predictable at all
   C vary greatly within a small local region
   D increase without any reason

5. Air pressure is greatest _____.
   A at the top of a tall waterslide
   B at the top of Grandfather Mountain
   C at the beach (sea level)
   D in an airplane

6. Low pressure causes _____.
   A blue sky
   B sunny sky with clouds
   C clouds and rain
   D nighttime

7. At sea level, pressure is greatest. This means that as you leave sea level and increase your elevation, pressure _____.
   A increases
   B decreases
   C stays the same
   D all of the above

8. Winds that affect all of planet Earth are called _____.
   A local winds
   B global winds
   C mountain breezes
   D sea breezes

9. At the equator, there is _____.
   A high rainfall and low pressure
   B low rainfall and low pressure
   C low rainfall and high pressure
   D low rainfall and no pressure

10. Where there is a lot of cloud cover, there is also a lot of _____.
    A rain
    B snow
    C fog
    D sunshine

11. During the day, land heats up causing the air above it to rise as it heats. As cool air moves in to take its place, what do we have?
    A sea breeze
    B land breeze
    C ocean wind
    D sunny breeze

12. At night in the mountains, the slopes cool rapidly causing a _____.
    A valley breeze
    B mountain snow
    C mountain breeze
    D warm up

13. Which of the following statements is ***correct***?
    A Warm air heats up faster than cool air cools.
    B Land heats more rapidly than water.
    C Sea breezes are weaker than mountain winds.
    D Water heats more rapidly than land.

14. All of the following are types of clouds ***except*** _____.
    A cumulus
    B nebular
    C cirrus
    D stratus

15. On a sunny day, you walk outside and see white clouds that look like cotton balls high in the sky. What ***most likely*** are these clouds?
    A cirrostratus
    B altostratus
    C nimbostratus
    D cirrocumulus

16. Stormy weather would ***most likely*** be associated with which of the following?
    A cumulonimbus
    B stratus
    C cirrus
    D cirrostratus

17. Clouds that cover the sky in a layer are _____.
    A cumulus
    B stratus
    C nimbus
    D high

18. The prefix *alto-* is usually with these clouds.
    A high level
    B low level
    C ground level
    D midlevel

19. Clear weather may be accompanied by what?
    A high level clouds
    B midlevel clouds
    C low level clouds
    D nimbus clouds

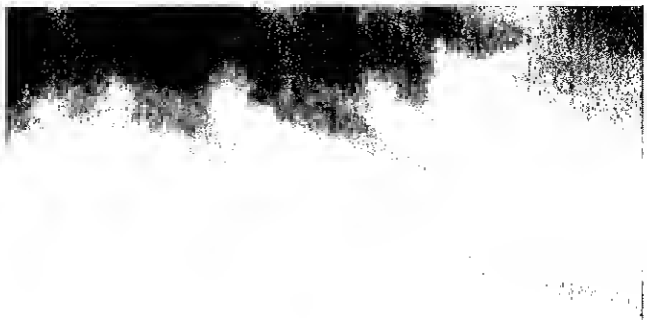
20. The sea of air around the Earth is known as the _____.
    A convection
    B atmosphere
    C current
    D wind

21. Objects moving through the air appear to turn because of the _____ effect.
    A Trade winds
    B Polar
    C Coriolis
    D Gulf Stream

22. The process of warm air being moved in cells is called _____.
    A convection
    B transduction
    C melting
    D electricity

23. Atmospheric pressure is measured by which of the following instruments?
    A thermometer
    B stethoscope
    C anemometer
    D barometer

24. The hair-like, wispy cloud shape, as seen in the diagram, is referred to as which basic type?

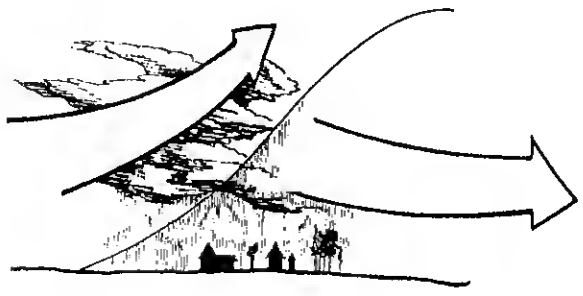


A cumulus
B cirrus
C stratus
D nimbus

25. A large part of the atmosphere with temperature and moisture like the surface below it is called _____.
A an air mass
B a convection cell
C the troposphere
D the greenhouse effect

26. What type of front separates two air masses that are not moving?
A a warm front
B a cold front
C a stationary front
D a convection front

27. A moving warm air mass, as shown in the diagram, constitutes what type of front?



A a warm front
B a cold front
C a stationary front
D a convection front

28. The patterns of temperature, precipitation, and humidity over a long period of time create an area's _____.
A weather
B region
C geography
D climate

29. Which layer of the atmosphere, called the zone of weather, is closest to the Earth?
A mesosphere
B troposphere
C stratosphere
D thermosphere

30. Which layer of the atmosphere contains the ozone layer which protects us against harmful UV radiation?
A mesosphere
B troposphere
C stratosphere
D thermosphere

31. Which of the following is the ***most common*** gas in our atmosphere?
A oxygen
B argon
C carbon dioxide
D nitrogen

32. A barometer shows that air pressure has been increasing. What type of weather would you predict?
A clear skies
B fog
C thunderstorms
D rain

33. The air above the valleys is warmed by the sun during the day. This warm air rises and flows up to the mountains creating a/an _____.
    A jet stream
    B mountain breeze
    C valley breeze
    D El Niño

34. _____ are the moist air masses that form over the ocean.
    A Giant air bubbles
    B Continental air masses
    C Frigid air masses
    D Maritime air masses

35. Which of the following air masses is very cold, forms over poles, and very dry due to extreme cold?
    A Continental Arctic
    B Maritime Polar
    C Continental Tropical
    D Maritime Tropical

36. The _____ of a place depends on the source of the air mass and the path of the air mass as it moves from its source region.
    A air
    B precipitation
    C temperature
    D terrain

37. Equatorial air masses are considered to be wet due to the _____ that add moisture to the air.
    A polar caps
    B tropical rainforests
    C deserts
    D altitudes

38. These large, violent storms are created over water, move counterclockwise, and form an eye in the center. What are these storms called?
    A tornadoes
    B lightning
    C thunderstorms
    D hurricanes

39. The leeward side of a mountain that receives the descending dry and warming air and is quite arid is called the _____.
    A orographic precipitation
    B rain shadow
    C Great Basin
    D ocean current

40. What happens when the winds in the tropics blow warm surface water out to sea?
    A A hurricane develops.
    B There is a low tide.
    C There is a high tide.
    D Cold water currents rise to the surface.

41. On a weather map, Asheville has H over it. What does this represent?
    A an area of high pressure
    B heavy snow
    C a warm air mass
    D a hot air mass

42. Watch the evening news tonight. When the weather is discussed, write down tomorrow's forecast.

    temperature high_____

    temperature low_____

    precipitation?_____

    humidity_____

    air pressure_____

    Are any cold fronts approaching?_____

43. You look up at the sky and see a low-hanging, thick blanket of clouds. Predict what kind of weather you will have that day.

    _____

    _____

44. Name two tools used by meteorologists to track the weather.

    _____

    _____

45. How do meteorologists help us plan our lives?

    _____

    _____

46. How might farmers use information from meteorologists?

    _____

    _____

47. How do meteorologists help keep people safe?

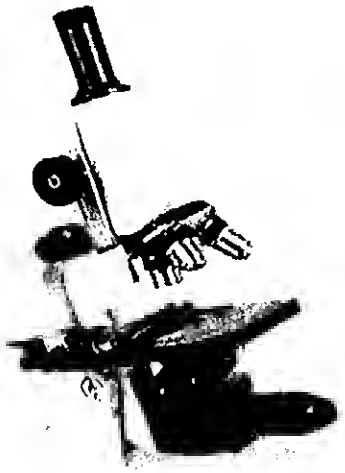
    _____

    _____

CHAPTER 5
LIVING ORGANISMS

PLANT AND ANIMAL CELLS

Just as an atom is the fundamental unit of all matter, there is a fundamental unit of living things, the **cell**. Discovered in 1665 by the English scientist **Robert Hooke**, the cell represents the basic unit of life. Hooke used the name cell because, when he first saw them under a microscope, they reminded him of the cubicles, or cells, that monks lived in. With the improvement of the microscope, other scientists were able to expand on Hooke's discovery and later develop the **cell theory**. Cell theory includes the following concepts:



The microscope was used to develop cell theory.

What is cell theory?

Cell Theory

- All living things contain at least one cell.
- Cells are the basic units of structure and function of life processes.
- Cells come from other cells of the same kind.

First organism that comes to mind

All organisms are composed of cells. Most organisms are **unicellular**, or made up of single cells. This includes entire kingdoms, like Protista, as well as part of the kingdom Archaebacteria, Eubacteria and Fungi. By far, single-celled organisms comprise the greatest biomass of life on Earth. Bacteria and amoebae are examples of single-celled organisms. Other organisms, like wolves, flies, trees, and humans, are **multicellular**, or made up of millions of cells working together.

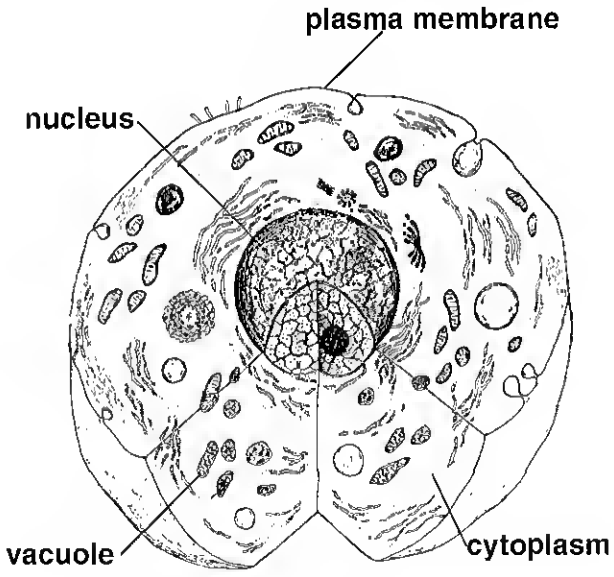
Why is the

Although cells are the fundamental units of life, they are composed of many different structures that work together to carry out the jobs required of the cell. Even though there are many different types of cells within most organisms, all of them have the basic function of producing **proteins** that are needed by either the whole organism or the cell itself. To carry out its requirements, the cell contains structures, called **organelles**, which are responsible for different activities.

The structure and function of a cell can be compared to a manufacturing company. As with a company, many different departments perform different tasks with the overall effect of contributing to the main goal, the manufacture of a product. In the cell, the products are mostly proteins.

Animal Cells

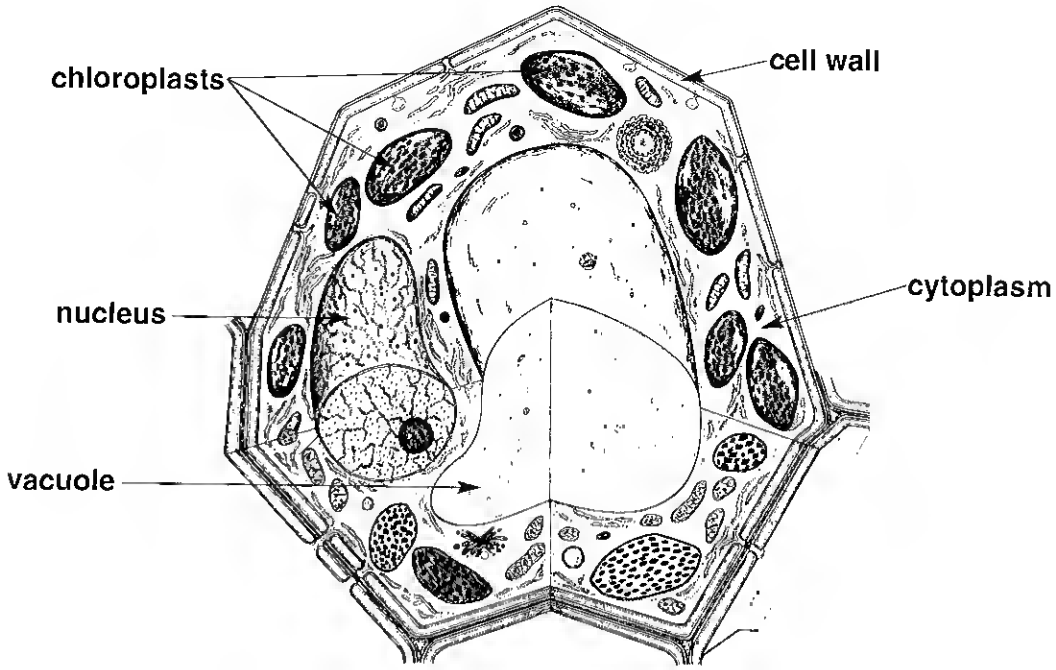
An animal cell is surrounded by a flexible, double-layered coat called a **plasma membrane**. The plasma membrane controls the transport of materials into and out of the cell. **Vacuoles** are storage bubbles inside the cytoplasm that hold food until it can be digested. Water, oxygen, nutrients, and waste all must pass through the plasma membrane.



THE ANIMAL CELL

The large, round structure inside the cell is called the **nucleus**. The nucleus is the command center of the cell. It contains all the information needed to direct the cell's behavior, including information about how to grow and divide. The nucleus floats in a jelly-like substance called the **cytoplasm**. The cytoplasm and the plasma membrane help to maintain the shape of the cell.

Plant Cells



THE PLANT CELL

Like the animal cell, the plant cell has an outer covering called the **cell wall**. However, this covering is not flexible like the animal plasma membrane, it is a rigid, protective covering. These rigid cell walls, lined up tightly together, help plants stand up. Like the animal cell, the plant cell has a **nucleus** which controls cell functions and floats in the **cytoplasm**. Plant cell **vacuoles** do more than store important substances. The water in these vacuoles puts pressure on the cell wall and causes the cell to become rigid. This gives the wall enough strength to hold up fairly large green plants. Think about this; plants use their rigid cell walls to stand up, while animals have muscles and bones for their support.

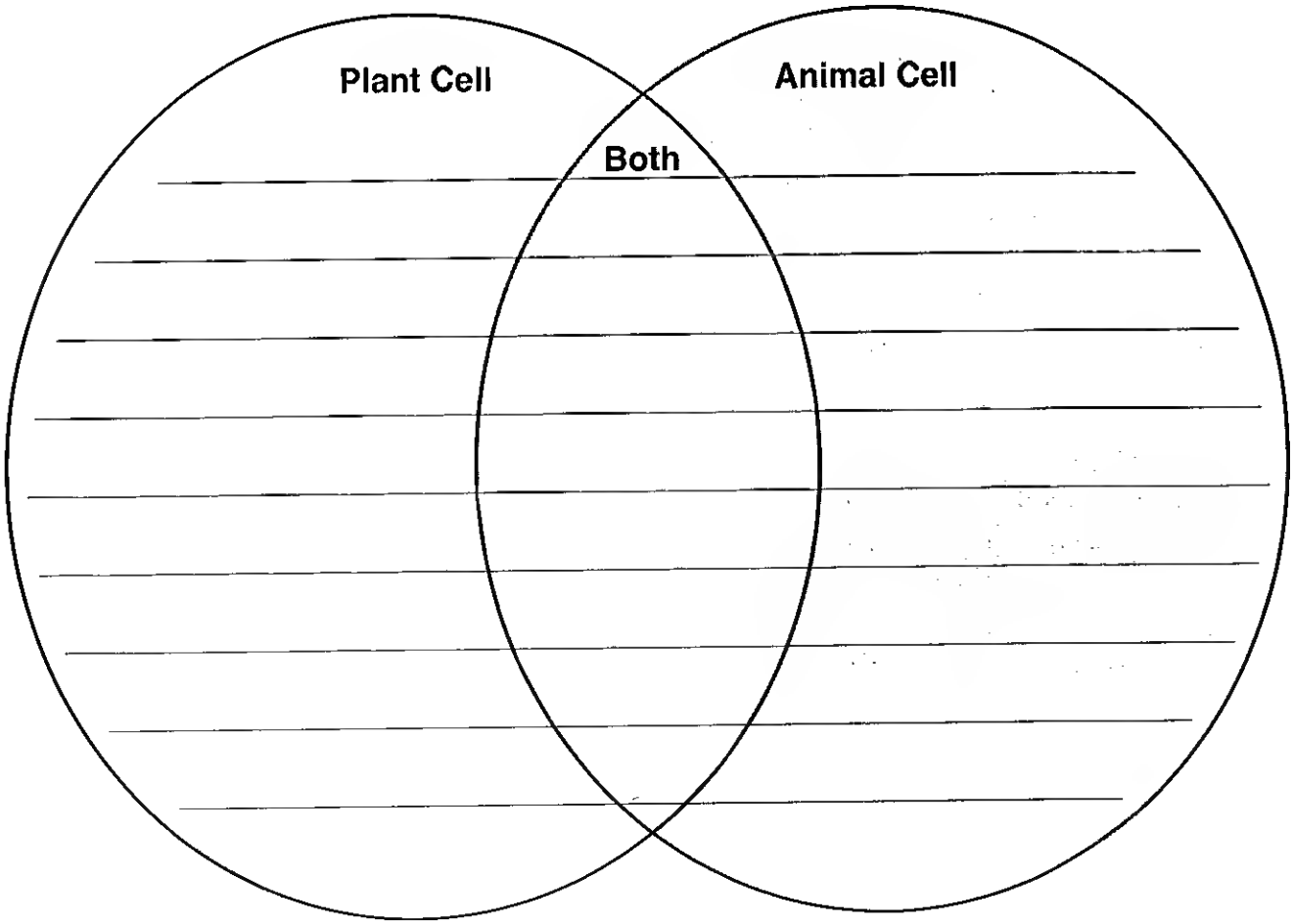
The plant cell is very different from the animal cell in that it contains structures called **chloroplasts**. Chloroplasts are a type of plastid, a sac that contains pigments that are used to convert the sun's energy into food for the cell. The chloroplast is the site of **photosynthesis**. Photosynthesis is the process whereby plants trap the energy of sunlight. This energy is combined with water and carbon dioxide and converted into sugar. The plant uses this chemical form of energy to build new plant tissue and to make seeds.

PRACTICE

Check the box of the cell type that matches the description.

1. Has a cell wall.
   ❑ animal ❑ plant ❑ both
2. Has a nucleus.
   ❑ animal ❑ plant ❑ both
3. Has a cytoplasm.
   ❑ animal ❑ plant ❑ both
4. Has a chloroplast.
   ❑ animal ❑ plant ❑ both
5. Has a plasma membrane.
   ❑ animal ❑ plant ❑ both
6. Performs photosynthesis.
   ❑ animal ❑ plant ❑ both
7. Has a vacuole.
   ❑ animal ❑ plant ❑ both

8. Think about plant and animal cells. Use the Venn diagram below to show how they are similar and how they are different.



9. Define the term cell.

10. What happens during photosynthesis?

11. Use the chart below to explain the job of each cell part.

nucleus	
cytoplasm	
vacuole	
plasma membrane	
chloroplasts	

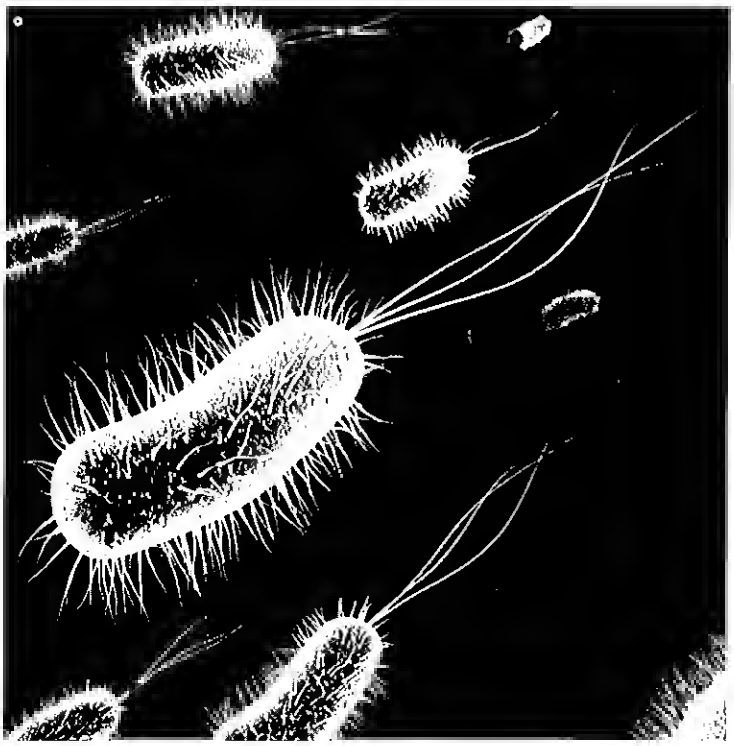
12. What is the purpose of organelles?

13. How could you distinguish a plant cell from an animal cell?

UNICELLULAR LIFE

The Kingdoms **Archaebacteria** and **Eubacteria** include the smallest and most primitive forms of life. Bacteria are microscopic organisms whose single cells have no membrane-enclosed nuclei. Bacteria can cause disease but some can be very beneficial. Some bacteria form a tough protective covering that allows for a sleeping period when conditions are not favorable. Bacteria have adapted to almost every environment on Earth.

Bacteria are also environmentally essential since they are **decomposers**. These bacteria feed on dead organic material and break it down into simpler forms that can be used by other organisms. Other ways bacteria are beneficial are their uses in medicine and foods. We use bacteria cultures to make yogurt, cheese and pickles. Bacteria are used to develop medicines such as erythromycin that help us kill bacterial illnesses. Bacteria are used in sewage treatment plants and septic tanks to help us break down our waste products. You can see that bacteria helps you in many ways.

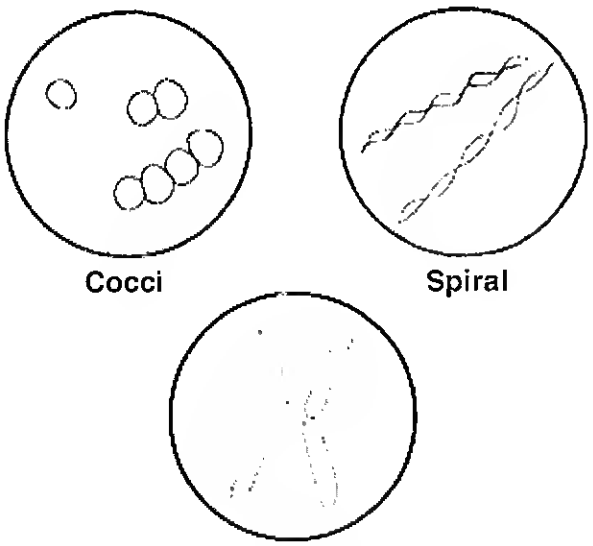


Bacteria can be used to break down our waste products.

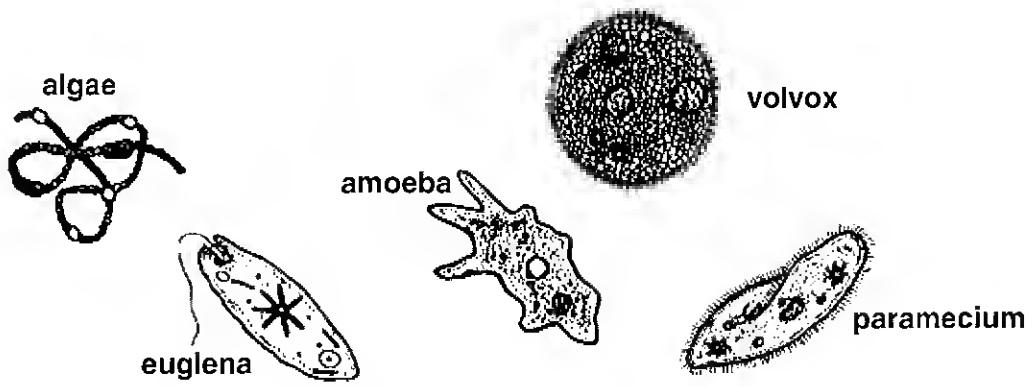
Keeping foods frozen or refrigerated enables us to keep foods fresh for longer periods of time because it reduces the chance that bacteria can reproduce. Other ways to control bacteria growth in foods include **pasteurization**, to increase the temperature, and **fermentation**, to lower the pH. On nonliving surfaces, **disinfectants** are used to kill bacteria. Bacterial growth is controlled on living surfaces, like skin, by the use of **antiseptics**.

Antibiotics are used to kill bacterial infections in animals and humans. However, because of improper use, bacteria can develop resistance to antibiotics. When the antibiotic is given, most of the bacteria die but some may survive. In order to kill all the bacteria, antibiotics need to be taken for the full time prescribed and only for non-viral illnesses. Bacteria cause diseases such as strep throat, tuberculosis, meningitis, bubonic plague, diphtheria, tetanus, and food poisoning.

Bacteria are grouped together by their cell shapes. There are three common shapes of bacteria. Some bacteria (***coccus***) are shaped like tiny **spheres**. *Streptococcus pyogenesis* is a coccus shaped bacteria that causes strep throat. Bacteria with **rod** shapes (***bacillus***), such as *Bacillus cereus*, inhabit the soil and are a common cause of food poisoning. **Spiral** shaped bacteria (***spirillum***) are able to move with assistance from structures called flagella on their ends. An example of a spiral bacteria are the *H. pylori*, which cause gastritis.



Other types of unicellular organisms come from the kingdom **Protista**. Examples of protists include **algae, amoebae, paramecia, volvox,** and **euglena**. **Algae** are plantlike protists. They contain chlorophyll that enables them to produce their own food by **photosynthesis**. They are important to the environment because they are the first link in most aquatic food chains. They also produce the oxygen necessary for cellular respiration in animals. Movement of small organisms is very interesting. Many bacteria and



some protists move by using a **flagellum**. Flagella are thread-like structures that whip around to move these small organisms. The euglena and volvox pictured have flagella. A paramecium moves by **cilia** located all around it. See the hair-like structures in the picture above. An amoeba moves by projecting out its cytoplasm. Those projections are called **pseudopodia**, which means false feet. Pseudopodia, cilia and flagella are used to bring food into the cell as well as for locomotion.

PRACTICE

1. How do we benefit from bacteria?

2. What are some diseases caused by bacteria?

3. Describe the method of locomotion for the amoeba, paramecium, and euglena.

MULTICELLULAR LIFE

Multicellular organisms are organisms that are made up of many different cells. Most multicellular organisms come from two kingdoms. Multicellular organisms have cells which contain a nucleus that is surrounded by a nuclear membrane and separated from the rest of the cell. The **Plant** kingdom includes more than 350,000 species. The plant cell contains a nucleus and other organelles including chloroplasts, which allow the plant to make use of the sun's energy by the process of photosynthesis. Examples of typical plants include **ferns, conifers** (evergreens), and the more numerous **flowering plants**, which include grasses, cereal grains, decorative flowers, and broadleaf trees such as oaks and maples. Plants belong to the category of **autotrophs**, meaning self-feeders. This means that plants make their own food using energy from the sun.

The kingdom **Animalia** includes more than one million species of organisms. Roughly 97% of these species are **invertebrate**, meaning without a backbone. There are sixteen divisions of animals varying by degree of complexity and specialization. Examples (simplest to most complex) include sponges, jellyfish, worms, spiders, insects, fish, lizards, birds, and mammals. These animals must ingest nutrients to survive. Most animals are **heterotrophs**, meaning other feeders. Heterotrophs obtain energy from other organisms.

CELLULAR PROCESSES

Even to a child there is a distinct difference between living and non-living things. What criteria must an object meet if it is to be called "alive"? There are certain characteristics that all living things have. They may be recognized by their ability to perform all of the following cellular processes:

1. **Absorption** is the process by which an organism takes in nutrients, oxygen, and water from its surroundings. These materials must pass through the plasma membrane by active or passive transport.
2. **Excretion** is the movement of waste materials out of the cell.
3. **Digestion** is the breakdown of food particles into molecules that can be used by the cell.
4. **Reproduction** is the process of transferring genetic information from parent to offspring in order to assure future generations of that type of organism.
5. **Response** describes the reaction of an organism to an outside stimulus. All organisms respond to stimuli in their environment in some form or another.

6. **Energy** is required by all organisms to carry out life processes. The intake of food, absorption of food molecules and excretion of waste are requirements for all types of life. Without these three processes, living things would not be able to obtain nutrients needed for growth and reproduction.

PRACTICE

1. What are multicellular organisms?

2. Compare and contrast the major characteristics of the Plant and Animal kingdoms.

3. Identify the following cellular processes.
   a. Starch is broken down into sugars by enzymes in saliva.

   b. Carbon dioxide is removed from a cell.

   c. An amoeba divides in two.

   d. A cell undergoes photosynthesis.

   e. Ducklings crouch when predatory birds fly overhead.

   f. An amoeba encircles smaller bacteria and closes around them.

HUMAN BODY SYSTEMS

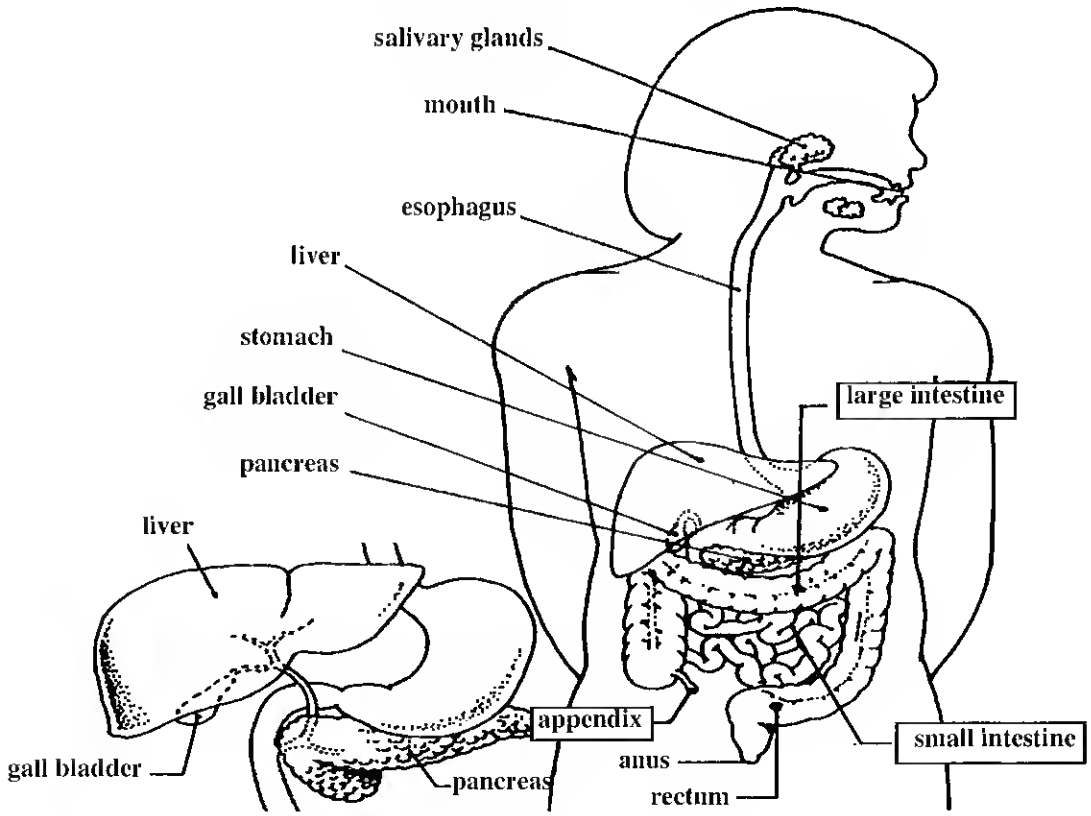
One-celled organisms are able to take in materials directly from their surroundings. Only surface cells can take in nutrients and give off wastes in plants and animals. Both plants and animals have **systems**, groups of parts working together for moving materials throughout their bodies. For example, blood cells in human bodies carry nutrients and oxygen through blood vessels. Tubes carry water and nutrients in some plants.

Many animals have body systems that are similar to humans. These systems carry information and materials from one part of the body to another part.

Take a look at the systems of the human body.

The Digestive System

The food that you eat is not in a form that your body can use instantly. Therefore, your body must change the food into a usable form. This process is called **digestion**. Large pieces of food are broken down into smaller pieces, which are then chemically changed. This is how your body is able to get the necessary nutrients from the food.



The Human Digestive System

The digestive system is made up of the **digestive tract**, which contains all of the digestive organs and is about 10 meters long. Some parts of it are narrow and other parts are wide. The food you eat travels along the digestive tract until it reaches its final destination and is eliminated by the body. By that time, the body has taken all the nutrients provided by the food.

The **mouth** chews, grinds, and swallows the food. Next, the food enters the **esophagus**, a long tube which leads to the **stomach**. A thin flap of tissue, the **epiglottis**, prevents food from entering your windpipe, which is near the esophagus. If food were to get into your windpipe, it could choke you. After leaving the stomach, the food goes into a narrow, coiled tube called the **small intestine**, then enters the **large intestine** to prepare for excretion through the **rectum**.

The stomach plays an important role in digestion. The **stomach** is a bag-like organ which breaks down food through physical and chemical means. The walls of the stomach squeeze together, breaking food into small pieces. Then, the stomach uses chemicals called **gastric juices**, which break down the foods into a form that can be absorbed by the body. **Pepsin** is a mucus-like substance which helps to digest protein. **Hydrochloric acid** is a strong acid that kills bacteria and breaks food down into simpler chemical forms.

Most of the chemical digestion of food takes place in the **small intestine.** Special chemicals called **enzymes** continue to break the food down into usable forms. Pepsin, found in the stomach, is an example of an enzyme. **Lipase** is an enzyme found in the small intestine which breaks down fats. After the food has been chemically processed, it is ready to be absorbed by the body. **Absorption** refers to the movement of food from the digestive tract to the blood. Once the nutrients are absorbed by the blood, they are taken to the cells for growth and energy.

The small intestine sends undigested food, minerals, and water on to the **large intestine**, sometimes called the **colon**. Here, water and minerals are absorbed into the bloodstream. Undigested foods, such as fiber, and leftover waste is passed along the large intestine where they finally exit the body at the rectum. The body benefits from fiber in the diet. **Fiber** is a substance found in many foods, like whole wheat breads, that cannot be digested by humans. But the fiber can help the body in several ways. Some fiber is believed to lower the absorption of excess fat. Fiber can also help to lower cholesterol levels. Finally, fiber helps to keep your large intestine running smoothly and is believed to prevent cancer of the colon.

Three other organs aid in digestion, even though they are not directly part of the digestive tract. The **pancreas** lies below the stomach and releases digestive juices containing enzymes, which break down food chemically. The **liver** is the body's largest internal organ. It produces bile, which is stored in the **gall bladder**, a small organ underneath the liver. Bile breaks down fat into smaller droplets. This process, called **emulsification**, occurs in the small intestine.

PRACTICE

1. Why must food be broken down into smaller pieces?

2. Why is the stomach such an important part of the digestive system?

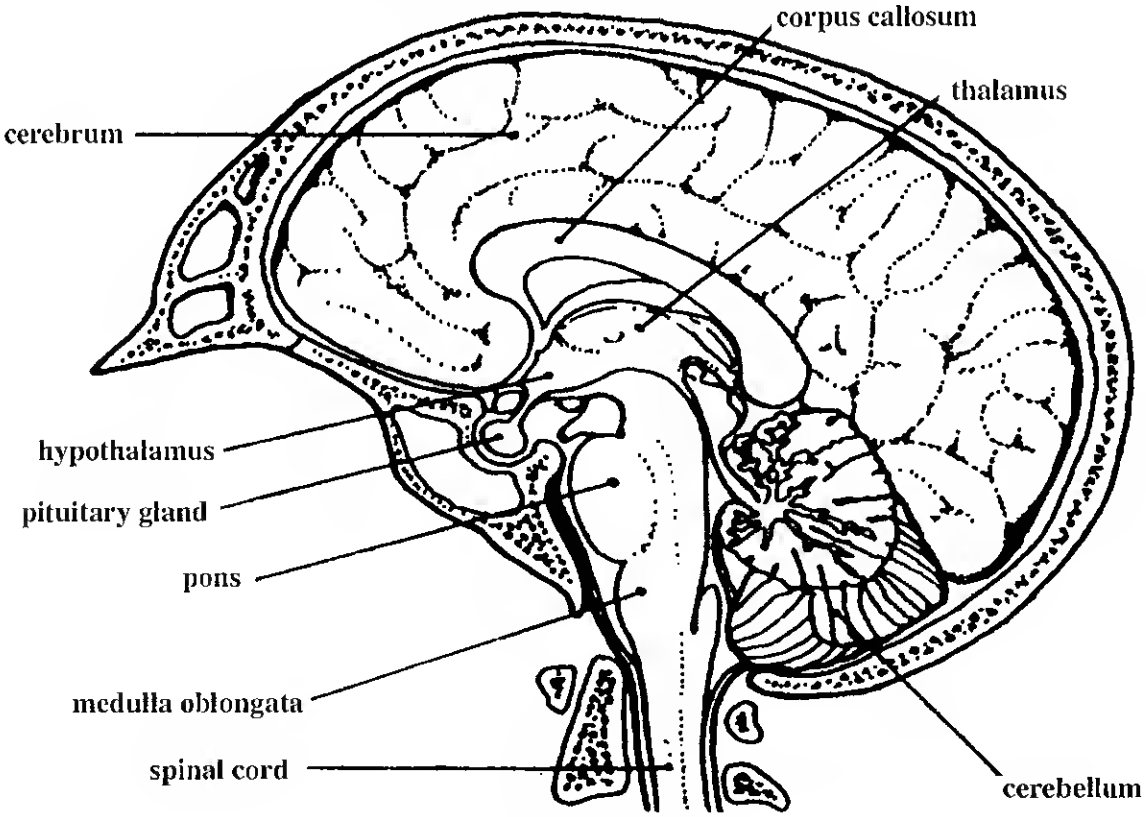
3. What happens to undigested food?

4. How does food reach the cells of the body?

5. Make a flowchart which shows the passage of food along the digestive tract, from the mouth to the rectum. Describe the processes that occur at each point along the way.

The Nervous System

The **nervous system** controls all of your body's activities. It consists of the brain, the spinal cord, and the network of nerves that run throughout the body. The nervous system directs your muscles and glands and is your body's way of controlling itself.

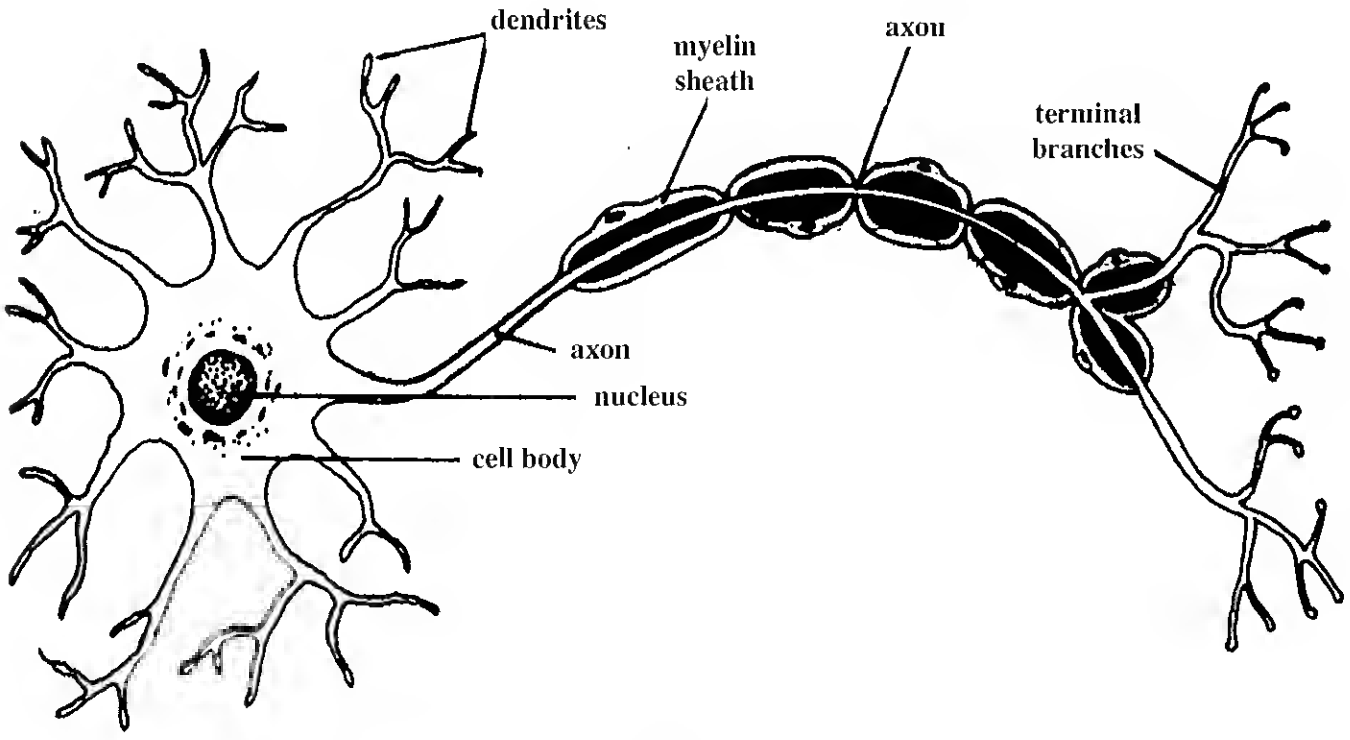


The Human Brain

The **brain** is the place where most of this control begins. The brain is underneath your skull. It is made up of nerve tissue. Its job is to receive and send messages. The messages may come from inside or outside your body. Some basic functions that are controlled by your brain include breathing, movement, thinking, and sleeping.

The brain is made up of three main parts. The **cerebrum** is what most people think of when they get an image of a brain. It is the largest part, and consisted of many creases, wrinkles, and folds. These increase the surface area of the cerebrum, allowing it to perform even more functions. The cerebrum receives and interprets information from your **sense organs**, such as your eyes, ears, nose, tongue, and skin. The cerebrum also aids in thinking, remembering, and making decisions. The cerebrum is divided into two halves, or hemispheres. These two hemispheres are responsible for different functions in the body but they are joined by a thick connection called the **corpus callosum.**

The **cerebellum** is at the back of the brain. This part of the brain controls all body movements and maintains balance. Athletes depend on the cerebellum to help them coordinate fine motor movements of their bodies. These activities are called **voluntary responses** because they involve purposeful movement. The **medulla** rests at the base of the brain. The medulla connects the brain to the spinal cord. It controls basic processes such as heartbeat, digestion, and breathing. These activities are called **involuntary responses** because they occur on their own and do not require any thought. Without the medulla, we would not be able to survive. It controls the most basic of all biological functions.



A Neuron

Neurons are special cells that carry impulses from the nervous system to different parts of your body. Your brain consists of millions of neurons. Without these cells, the brain's ability to send and receive messages would disappear. **Dendrites** carry nerve impulses from neighboring cells *toward* the cell body of the neuron. **Axons** carry nerve impulses *away* from the cell body to other neurons. Axons act as a long cable connection. Some axons, like the ones running down your legs, can be as long as three feet! The axon is covered by a layer of fatty material called the myelin sheath. The **myelin sheath** acts as insulation so that nerve impulses don't stray off course. Once the neural message reaches the end of the axon, at the **terminal branches**, it is carried across a tiny space, called the **synapse**, and is picked up by the dendrites of another neuron. This process occurs in just a fraction of a second, and millions of neural impulses occur in your body each day.

PRACTICE

1. What is the job of the nervous system?

2. What is the job of the cerebrum?

3. Why do organisms need the medulla in order to survive?

4. Why would athletes need to have a highly developed cerebellum?

5. Design a flow chart to show how a message is sent from one neuron to another.

6. Surgeons today are able to transplant, or exchange, many different types of organs from one human body to another. Considering the complexity of the human nervous system, do you think that it will ever be possible to have brain transplants? Why or why not?

The Endocrine System

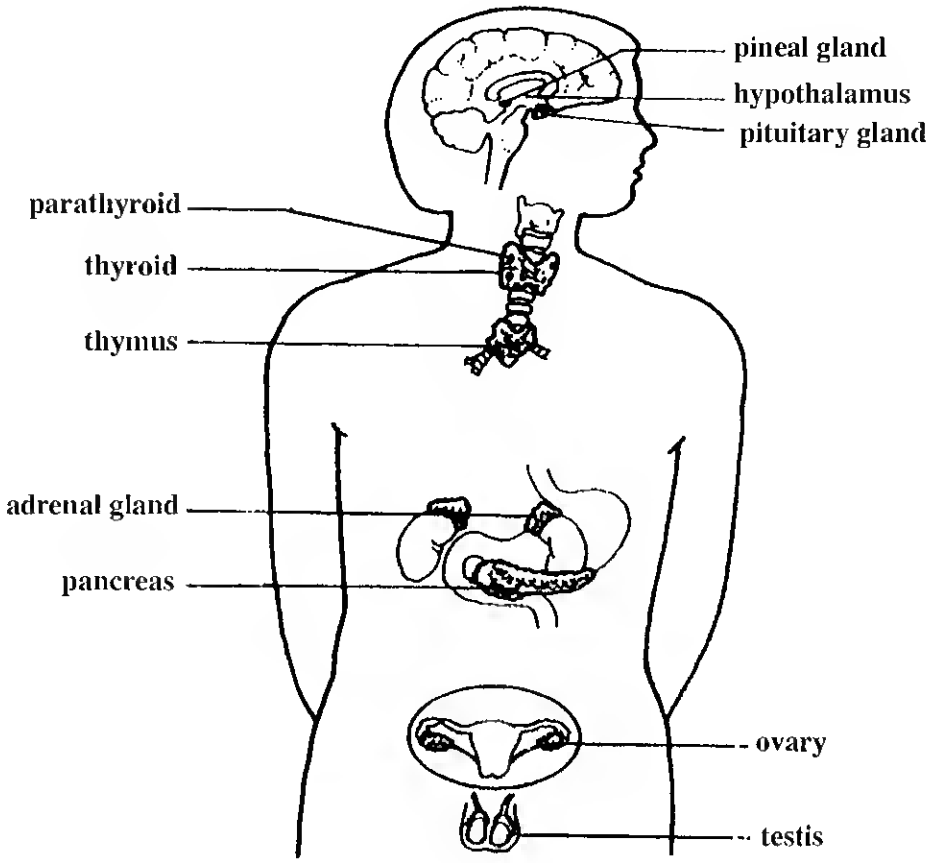
The human endocrine system consists of about ten glands. A **gland** is an organ that makes chemical substances used by the body. Some glands release their substances through **ducts,** or channels. For example, your salivary glands, found in your mouth, release saliva into the mouth through a series of ducts whenever you are ready to eat. Sweat glands release perspiration through ducts which lead to the skin. This helps to control your body temperature. Other glands do not have ducts. These glands are the ones that make up your body's endocrine system.

The purpose of the **endocrine system** is to control body functions. Therefore, it works hand in hand with the nervous system, which also controls body functions. Each gland in the endocrine system has a different job. The different glands are all controlled by an endocrine gland in the brain called the **hypothalamus**. The hypothalamus acts like a thermostat. If it senses that the body needs a chemical substance to be released, then it stimulates the appropriate endocrine gland to release that chemical, much like a thermostat would tell a heater or an air conditioner to turn on or off.

HORMONES IN THE HUMAN BODY

Gland	Hormone	Function
Adrenal	Adrenalin	Controls muscles, blood clotting, and blood pressure
Ovaries	Estrogen Progesterone	Stimulates the growth and development of the female reproductive system
Pancreas	Insulin Glucagon	To lower or raise the levels of blood sugar in the body
Pineal	Melatonin	Regulates the pituitary; involved in sleep-wake cycle
Pituitary	Human Growth Hormone	Regulates the speed of growth of your body
Testes	Testosterone	Stimulates the growth and development of the male reproductive system
Thyroid	Thyroxin	Controls the rate of metabolism

The chemical substances made by the endocrine glands are called **hormones**. These hormones influence many of your body's functions. For example, **melatonin**, which is produced by the **pineal gland**, helps to control when you get sleepy each day. The hormone **insulin** is produced by the **pancreas** and, along with another hormone called **glucagon,** it helps to control the levels of blood sugar in the human body.



Human Endocrine System

Thyroxin is the hormone produced by the **thyroid gland**. This hormone regulates metabolism. **Metabolism** refers to the rate at which your body uses energy. If you don't produce enough thyroxin, your body's metabolism slows down and you may feel sluggish. Other people may have an overactive thyroid gland which produces too much thyroxin. These people may need to eat constantly, since their body uses energy so quickly. Yet they may still be thin!

Special hormones are responsible for the growth and development of the reproductive organs. Men have glands called **testes** which produce **testosterone**. Females have glands called **ovaries** which produce hormones called **estrogen** and **progesterone**. These hormones are necessary for humans to be able to reproduce.

PRACTICE

1. What is the difference between glands like salivary glands and glands like the thyroid glands?

2. Using the diagram of the endocrine system, identify which endocrine glands occur in pairs in the human body.

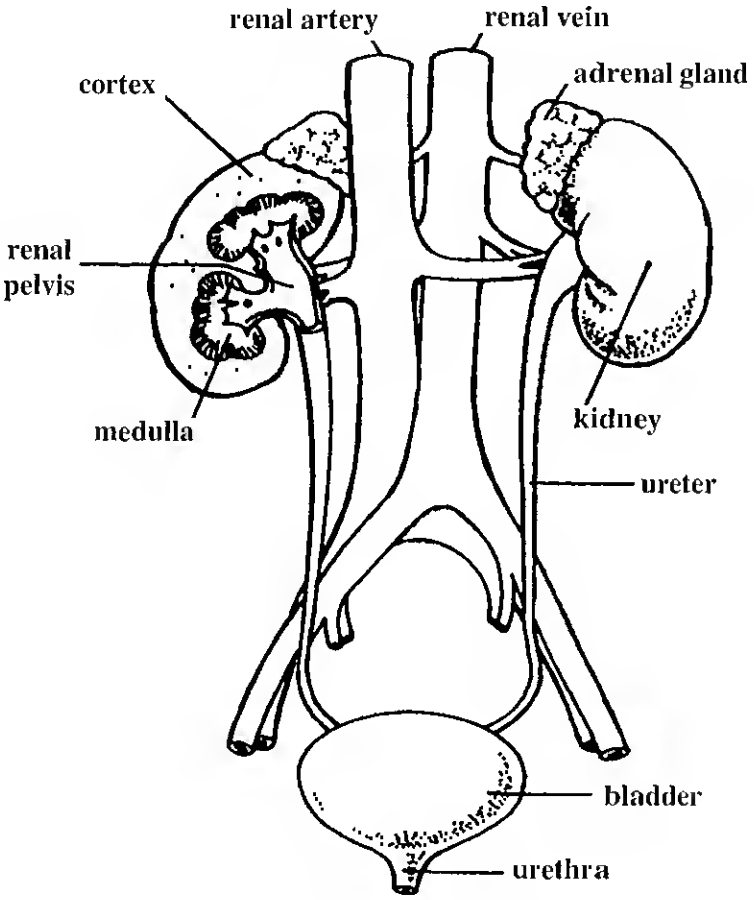
3. What is the purpose of the hypothalamus?

4. What health problems would a person have if his/her pituitary gland secreted too much or too little human growth hormone?

The Excretory System

Excretion is the process of removing wastes from the body. Many waste products are formed from your cells. Carbon dioxide and water are waste products that result from cellular respiration. Salts and nitrogen compounds are also waste that are produced by cells. Your body must have some way to eliminate these potentially harmful wastes. This process is called excretion.

The **excretory system** is made up of the lungs, kidneys, skin, intestines, rectum, and anus. The **lungs** are essential in respiration and thus get rid of carbon dioxide and water from cellular respiration. You can tell that water is eliminated from your lungs by holding a mirror to your mouth and breathing onto it. Water vapor will form.



Human Excretory System

The **kidneys** get rid of liquid wastes from the body. The liquid waste formed in the kidneys is called **urine**, which consists of water, salts, and urea. **Urea**, a nitrogen compound, is a waste product formed when proteins are used by the body.

Kidneys act as the filters of the excretory system. Millions of tiny tubes inside the kidneys filter water and other materials out of the blood. The waste product, urine, then fills a cuplike structure and is passed along the tube into the **ureters**. Urine then passes into the **bladder**, where it is collected and finally eliminated through the **urethra**.

Your **skin** is the largest organ of your body. It covers the entire surface area of your body and is necessary for getting rid of extra heat. Your skin contains **sweat glands**, which release **perspiration** through openings called **pores**. This is a type of built-in cooling system that allows your body to maintain a constant temperature. This is important in maintaining **homeostasis**. The **evaporation** of the perspiration from your skin cools the body and removes heat.

Undigested **food** moves from the **small intestine** to the large intestine, where water is removed. There, it becomes solid. As the solid waste passes through the **large intestine**, it enters the **rectum** and is excreted through the **anus**.

PRACTICE

1. What is the purpose of the excretory system?

2. How is the kidney system like a filtration system?

3. How does the skin act as a cooling system?

4. Why would it be important to take in salt when the weather is extremely hot?

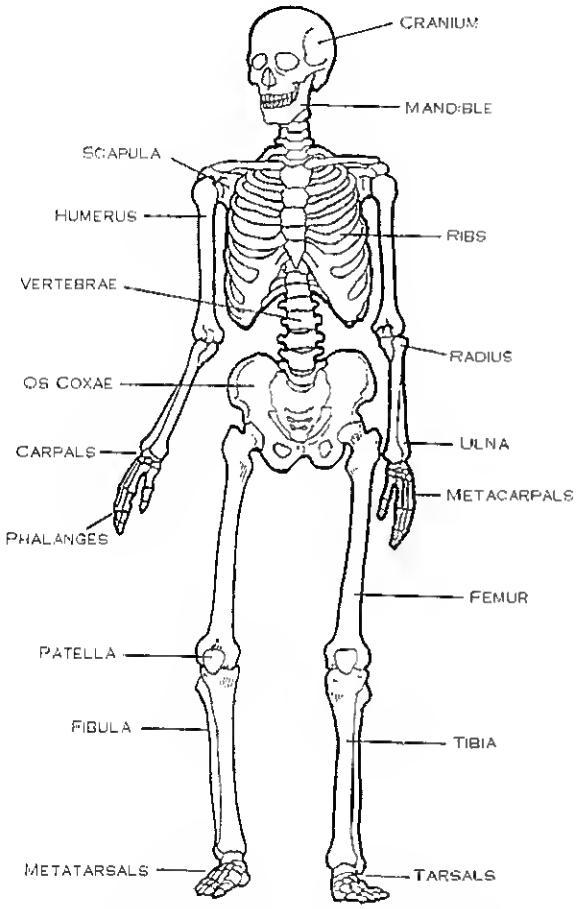
The Skeletal System

Humans have a framework that allows them to keep their shape. This framework is called the **skeletal system**. Most of the skeletal system of humans is made up of a very hard tissue called **bone**. Bones form our **skeleton**. Even though bones are very hard, they can break. Most of us have had broken bones at one time or another. With proper treatment, bone tissue can repair itself and once again, provide the necessary framework to support our bodies.

Many animals, like worms, do not have skeletons at all. Their bodies are totally soft and can change shape easily. But for animals that do have skeletons, they can be one of two types. Animals like grasshoppers have a tough skeleton on the outside of their bodies. This skeleton is called an **exoskeleton**. It protects the inside parts of the animal.

Other animals, like humans and fish, have their skeletons on the inside. These skeletons are called **endoskeletons**. The skeletons are still tough, but are now protected by a covering of skin and tissue.

Not all of our skeleton is made up of bone. Parts of our bodies have a softer tissue called **cartilage**. It is a flexible, but tough, connective tissue that provides a "cushion" in different parts of the body. As babies develop in the womb, their skeletons of cartilage gradually get replaced by bone. Cartilage can be found on the tip of your nose, as well as in other "soft" parts of your body. Bone is connected to bone by **ligaments**.



Humans have a tough internal skeleton.

Your skeletal system provides support for your body. But besides that, there are other important jobs that it does. It helps to move your body by working together with muscles. It also protects the internal organs of your body. Your rib cage, made up of individual bones called ribs, protects several important organs, like your heart and lungs. Your skull protects your brain. Some bones produce red blood cells, which your body needs to carry out its life functions.

PRACTICE

1. What are some of the functions of the human skeletal system?

2. a. What are some advantages of organisms which have an exoskeleton?

   b. What might be some of the disadvantages?

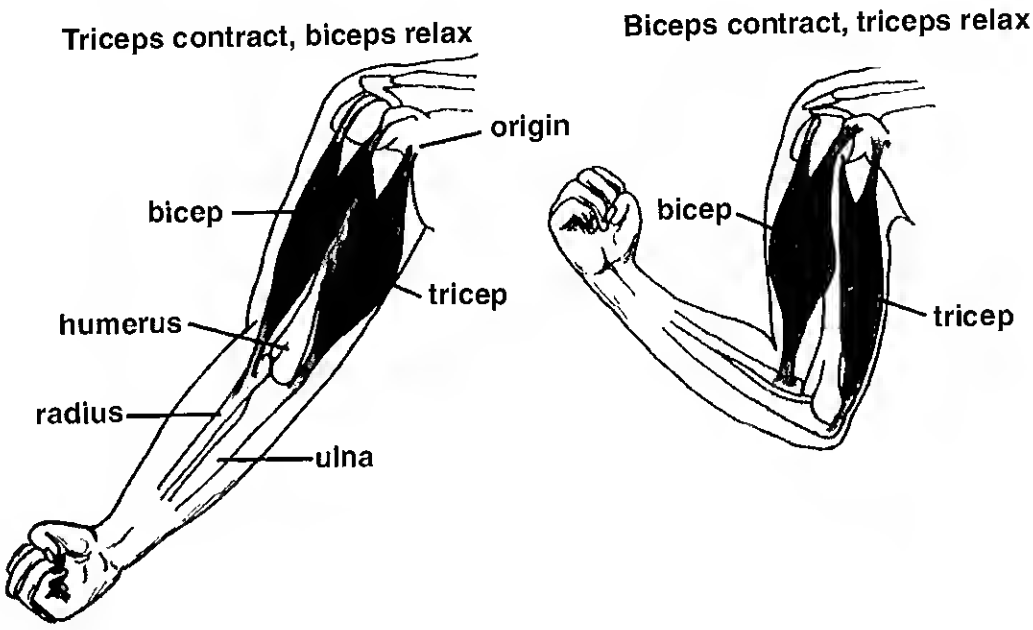
3. Name some other animals besides humans which have endoskeletons.

4. What is cartilage?

The Muscular System

There are more than 600 muscles in the human muscular system. **Muscles** are tissues that can shorten along their length, therefore causing movement in the body. Without muscles, we would be unable to move. **Tendons** are bands of connective tissue that attach muscle to bone. When a muscle shortens, or **contracts**, it pulls on the tendon, which then makes the bone move.

Muscles can move only when they contract. Therefore, they can only pull on bones, not push them. In your arm, there are muscles that bend your elbow. These muscles are called **biceps**. When you contract your biceps, your arm will move up. Muscles that bend, or flex, a joint are therefore called **flexor muscles**. Other muscles straighten out a joint. In your arm, for example, these muscles are called triceps. When you contract your **triceps**, your arm will straighten out. Muscles that straighten, or extend, a joint are therefore called **extensor muscles**.



When the biceps contract, the arm is pulled up.
When the triceps contract, the arm is pulled down.

Muscles usually work in pairs to allow for natural movement of our bodies. Biceps and triceps work as a team to move our arms. When the biceps are contracted, the triceps are relaxed. And when the biceps are relaxed, the triceps are contracted. The same type of teamwork occurs in the muscles of the knee.

PRACTICE

1. What is the main purpose of the muscular system?

2. a. What do flexor muscles do?

b. What do extensor muscles do?

3. Why do muscles usually work in pairs?

4. What do tendons do?

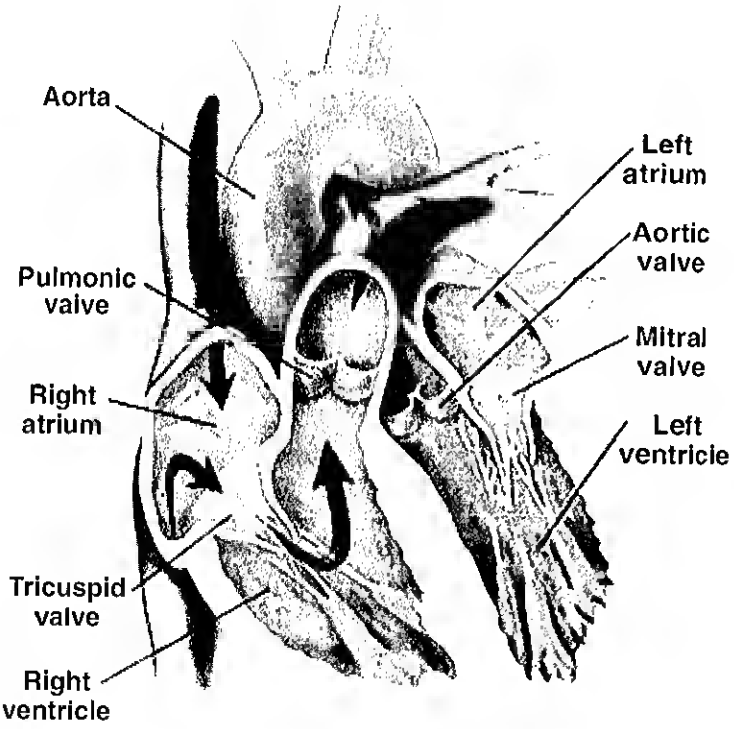
The Cardiovascular System

The **circulatory system** is the body's main **transport system**. It is made up of the blood, arteries, veins, capillaries, and heart. The **blood** is the liquid that transports the oxygen, carbon dioxide, hormones, nutrition and wastes. The liquid part of the blood is called **plasma**. It is about 90% water. The rest of the plasma is proteins, glucose and salts. Liquid wastes are also carried in the plasma to take the wastes to the organs of excretion. The solid part of the blood is made up of **red blood cells**, **white blood cells** and **platelets**. The red blood cells have **hemoglobin** which carries the oxygen around in the body. White blood cells help us to fight infections in our body. Platelets help us to clot our blood when we cut ourselves. We have what is called a **closed circulatory system** which means the blood is contained in the heart and the vessels.

Arteries take the blood from the heart to the body. They are thick walled muscular tubes that are under high pressure so they can get the blood all over the whole body. The artery that leaves the heart and enters the lungs is called the **pulmonary artery.** It is the only artery that carries blood with a low amount of oxygen (deoxygenated blood). The artery leaving the heart and going to the rest of the body is called the **aorta**.

Veins take the blood from the body to the heart and are called the vena cava. The superior vena cava returns blood from above the heart back to the heart. The inferior vena cava returns blood from the lower body to the heart. The pulmonary vein returns blood from the lungs and is the only vein that has oxygenated blood.

Capillaries are narrow tubes that go from the arteries to the veins. They are very thin and carry blood to our tissues. Since their walls are so thin, the oxygen, food and waste products can easily pass through them and go into or out of the tissue cells.



Humans have a four-chambered heart.

Your **heart** is about the size of your fist and is located between your lungs. The heart is a muscle made up of specialized cells called **pacemaker cells**. These cells help the heart to beat voluntarily. That means we do not have to tell the heart to beat. It does so automatically. The heart contains four **chambers**. There are a right ventricle and right atrium which takes blood in and out of the lungs. There is a left atrium and ventricle which takes the blood to the body. The two **atria** (plural) receive the blood entering the heart. The two **ventricles** send the blood to the arteries. There are **atrioventricular valves** that come between the atrium and ventricles. When the ventricles are pushing the blood into the arteries, these valves keep the blood from going into the atria. There are two **semilunar valves** at the opening of the arteries. This keeps blood from flowing back into the ventricles.

PRACTICE

1. How many chambers are in the heart? Name them.

2. What side of the heart gets the oxygenated blood? What side of the heart gets the deoxygenated blood?

3. What is the function of the valves in the heart?

4. A closed circulatory system means the blood that travels throughout the body stays in vessels. Why do you think humans have a closed circulatory system?

5. Name the large veins that bring the blood back to the heart.

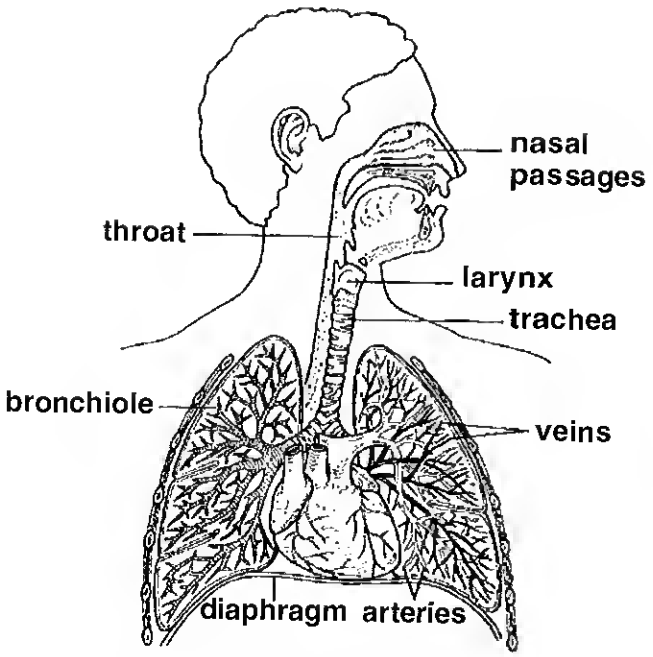
6. Trace a drop of blood from the right atrium and tell where it goes next. Trace the drop of blood from the right atrium until it leaves the heart in the aorta.

7. Name the parts of the blood and give their functions.

The Respiratory System

The **respiratory system** exchanges gases between the air and blood. You take in oxygen for your body and remove carbon dioxide from your body. **Inhale** means to take in gases and **exhale** is to take out or remove gases. You need oxygen in your body to break down glucose so your body can use it. Normally you inhale and exhale at a rate of 12-20 times per minute at rest.

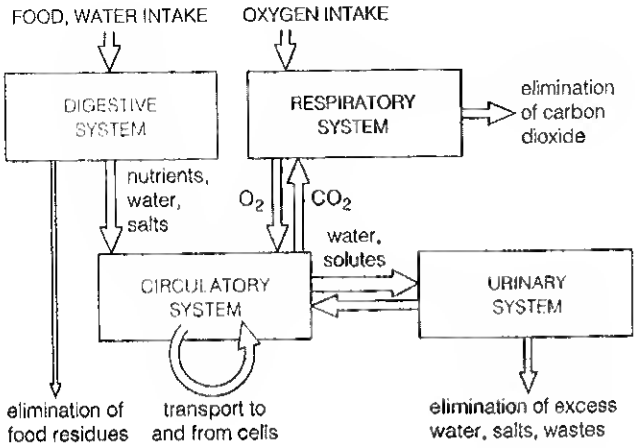
The respiratory system begins with the **nose** where you inhale the oxygen you need. Also, the nose helps to filter the air you breathe. That is the purpose of the hair in your nose. Next the air moves from the nose to **trachea**. After the trachea the gases travel into the two bronchi (one for each lung) and then to the two **bronchioles**.



Tiny air sacs called alveoli, located in bronchial tissue, are the site of gas exchange in human lungs.

The bronchioles lead into the **lungs**. Inside the lungs there are tiny sacs called alveoli. The gases are exchanged in the capillaries of the **alveoli**. The **diaphragm**, a thin muscle at the bottom of the thoracic cavity, moves down (contracts) and allows more air to enter the lungs. The air rushes into the lungs because when the diaphragm moves down, it is an area of lower gas volume than outside.

Oxygen is placed into your bloodstream in the alveoli so you can use it and it goes from the capillaries to the arteries and then to your entire body. **Carbon dioxide** diffuses into the red blood cells and is removed from the blood through the veins and capillaries in the alveoli and then to your lungs, bronchioles, bronchi, trachea and out the nose when you exhale.



The organ systems of the human body work together like parts of a big machine. All of your body's organs work together to provide a stable living environment. This interaction between organs is illustrated in the diagram.

Notice the digestive and respiratory systems are responsible for the intake of necessary food, water, and oxygen. All organs are responsible for the elimination of unnecessary or harmful wastes.

PRACTICE

1. What is the function of the respiratory system?

2. There are over 300 million alveoli in our lungs. What is their purpose?

3. Put these parts of our breathing system in order: bronchioles, nose, trachea, bronchi, lungs, alveoli

4. What is the difference between breathing and respiration?

INHERITED TRAITS AND ENVIRONMENTAL INFLUENCES

There are many characteristics that make you what you are. These are called **traits**.

Has anyone ever told you that you have your mother's eyes? This is an example of an **inherited trait**. An inherited trait is a feature you are born with. You don't have to learn how to have eyes like your mother—you were just born that way. Most organisms, even insects and plants, look like their parents. For example, the dogwood, your state flower, inherited its white color from its parents.

Can you roll your tongue? Can your parents roll their tongues?

Eye and flower color are very obvious inherited traits that are easily seen. They contribute to how an organism looks. Another example of an inherited trait is our ability to whistle. In this picture, the boy is rolling his tongue. To be able to whistle, you must be able to roll your tongue. Rolling the tongue is a dominant inherited trait. Other inherited traits may not be as easy to see and may determine how an organism behaves. An example of inherited behavior is a chick pecking its way out of an egg. A newly hatched butterfly spreads its wings and flies. A baby cuttlefish captures and eats the very first shrimp it sees.

The behaviors described above are called **instincts**. Instincts are traits that guide behavior and are passed from parents to offspring. Without instincts, animals could not survive. For example, a newborn baby instinctively cries when it is hungry. Crying lets the parents know the baby is hungry so it will be fed. When a fawn senses a predator, it instinctively stops in its tracks, or freezes. This makes the fawn less likely to be noticed and attacked. Instincts are behaviors that do not depend on experience or learning.

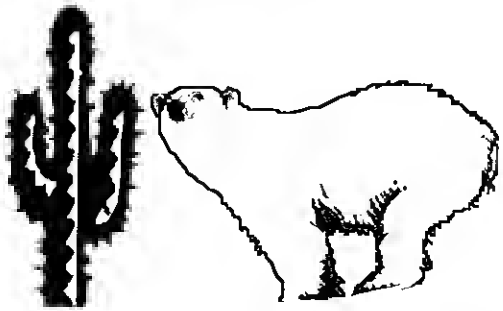
A baby cries to let his parents know he is hungry.

In some cases, traits may be influenced by environmental factors. Both nature (genetic inheritance) and nurture (environmental influences) play a role in shaping an organism's behavior. **Inherited traits** and environmental influences make you who you are.

Environmental influences can affect your inherited traits. If your parents are tall, then you have the inherited trait to be tall. But what if you do not get the right nutrition or sleep? Will you grow as tall as you could? Are people smart because they inherited intelligence from their parents or are they smart because of their environment (they study hard, eat right and get the right amount of sleep, etc.)? What do you think?

It is difficult to separate the influence of nature (genes) from the influence of nurture (environment). For example, thousands of years ago, all cats were wild. Over time, some cats became pets. We call them domesticated cats. We used selective breeding techniques to control the genetic inheritance and to get the desired physical characteristics of domestic cats. But environmental influences were also used to train cats to be pets and not attack.

Another example of the combination of nature and nurture is in adaptations of organisms. **Adaptations** are what you do to make you and your generations better able to live in the environment. Organisms which do not, or cannot, respond to changes in the environment reduce their chances for surviving. This may mean death for the individual organism and, in extreme cases, extinction of the species if too many die before they are



Neither the cactus nor the polar bear would be able to survive in the other's environment without adaptations.

able to reproduce. Response to the environment is, therefore, closely related to adaptation. Traits that allow organisms to survive and reproduce are passed on to future generations through the genetic code. So adaptations involve both inherited traits and environmental influences.

One very important adaptation is that of **response**. Response characteristics of cells enable organisms to react to stimuli in their environment. A group of complex responses is called a **behavior**. A **reflex** is an involuntary response to environmental stimuli. An **instinct** is a genetically controlled behavior. Some examples of these two responses are below:

Reflex: *A person's eye blinks as an object flies past it.*
A dog sneezes when it inhales pepper.

Instinct: *Birds respond to changes in season by migrating.*
A bee develops into a drone.

Birds building a nest is an example of instinct.

The adaptations an organism makes to respond to **environmental stimuli** can be essential to its survival. Amoebae cannot survive extreme pH conditions. When a drop of acid is placed near an amoeba, it responds by moving away. Plants respond to gravity by sending roots "down." A snowshoe rabbit's fur turns white in winter, making it more difficult for predators to spot it. People get a "rush" of the hormone adrenalin when a dangerous situation arises.

Learned Behaviors

While animals are born knowing some things, others must be **learned**. For example, a squirrel is born with the urge to eat nuts, but not the ability to crack them. An experienced squirrel will grasp a nut and gnaw at a natural groove. When the groove is deep

enough, the squirrel will give it a quick, hard bite and the nut will open. However, an inexperienced squirrel will gnaw all over the nut. Its bites will not open it. Sooner or later the young squirrel discovers the natural groove, and it no longer wastes its time on the other areas. It has "learned" to crack nuts.

Similarly, young lions are not born knowing how to **hunt**. A young lion cub follows its mother and watches her hunt. After ten months or so the cub has learned how to stalk, avoid detection, and move like its mother. When the cub is about two years old, it will use these skills in its first big game hunt. The cub will do some things right, like grabbing the head and avoiding the horns. However, it lacks the experience to throw a large animal to the ground. It may take several tries for the young lion to succeed. However, the cub is highly motivated. If it keeps failing, it will starve. These learned behaviors and the lions natural instincts are patterns of behavior that help the lion survive.

Population Variations

A **biological species** is a group of organisms having a genetic makeup that is similar enough that they can mate and produce fertile offspring. A **population** is made up of all members of a particular species living in a particular area at the same time.

For example, all the ducks of a certain species living in a pond would be a population. Within that population, individual ducks may vary in many traits, such as size. However, most members of the duck population could be described by an average size. Over time, changes in the duck population may occur. For example, duck size could be dependent on environmental factors that might affect availability of the food supply.

A population of ducks in their natural habitat

Changes in populations can also result from geographic isolation. **Geographic isolation** occurs when a population becomes separated by changes in the environment. An example might be a change in a river's course. After several generations, these isolated organisms may change significantly enough to form a new species through natural selection and genetic changes. These genetic changes result from mutations or crossing over. Isolated ponds in Death Valley, California, contain fish species that exist only in one pond. These different species were probably once members of a single population of fish that lived in the lake that once covered all of Death Valley. As the region dried, they became isolated and developed into different species.

Abert Squirrel of the South Rim **Kaibab Squirrel of the North Rim**

These two squirrels formed separate populations when the Colorado River split their species in the Grand Canyon.

The Kaibab squirrel is an example of evolution occurring through geographic isolation. The habitat of the Kaibab squirrel is confined entirely to the ponderosa pine forests of the North Rim of Grand Canyon National Park. The Kaibab squirrel is related to the Abert's squirrel which is found on the South Rim of the Grand Canyon. As the Grand Canyon formed because of erosion, it separated the ponderosa pine forests on each rim from each other. The isolated squirrels of the North Rim evolved into what is now a distinct subspecies with different characteristics.

PRACTICE

1. Name a visible trait a kitten inherits from its parents.

_____

_____

2. Name a behavior a kitten inherits from its parents.

_____

_____

3. Is crawling an instinct or a learned behavior for a human infant?

_____

4. How do animals learn behavior?

5. You go to the circus and see a lion jump through a hoop. Infer whether this is an instinct or a learned behavior.

6. Name some obvious features you inherited from your parents.

   Mom _____

   Dad _____

7. Name a special talent you may have inherited from your:

   Mom _____

   Dad _____

8. Name a mannerism or behavior you may have inherited from your:

   Mom _____

   Dad _____

9. You were not born knowing how to walk. What are some other things you learned as you got older?

10. Name some things you look forward to learning.

11. What are some things a puppy has to learn?

12. Explain the difference between an instinct and a learned behavior.

13. What is the difference between an inherited trait and an environmental influence?

14. Why are adaptations of organisms important?

15. Explain the difference between a reflex and an instinct. Give some examples.

16. What are environmental stimuli? Give an example.

17. What is the relationship between a species and a population?

18. What causes a new species to form?

19. Explain geographic isolation and give an example.

20. Describe how a new species might be formed from an existing one.

Chapter 5 Review

1. Behaviors that organisms are born with are called _____.
   A stimuli
   B adaptations
   C instincts
   D learned behaviors

2. The first person to observe cells under a microscope was _____.
   A Louis Pasteur
   B Alexander Fleming
   C Robert Hooke
   D Edward Jenner

3. Which of the following statements is true?
   A Bacteria are harmful to our body.
   B Bacteria are helpful to our body.
   C Both A and B are true.
   D Neither A nor B is true.

4. All of the following organ systems help to prevent infection ***except*** the _____.
   A digestive system
   B nervous system
   C respiratory system
   D circulatory system

5. Plant cells but not animal cells have _____.
   A a nucleus
   B vacuoles
   C a plasma membrane
   D a cell wall

6. The characteristics that an organism inherits are referred to as _____.
   A genes
   B chromosomes
   C traits
   D DNA

7. What is the difference between a plant and an animal cell?

   _____

   _____

   _____

   _____

8. Which kind of tissues can contract?
   A muscle
   B nervous
   C bone
   D connective

9. The tiny, thin vessels of the circulatory system that make it easy for nutrition, oxygen, carbon dioxide and wastes to enter or leave tissues are called _____.
   A arteries
   B veins
   C capillaries
   D platelets

10. The thick walled chambers of the heart are called the _____ and serve to _____.
    A atria; send blood away from the heart
    B atria: send blood to the heart
    C ventricles; send blood to the body
    D ventricles; send blood to the heart

11. The connective tissue that connects muscle to bone is called a _____.
    A tendon
    B cardiac muscle
    C ligament
    D valve

12. Which one of the following is the correct path of blood circulation?
    A left atrium, left ventricle, lungs, right atrium, right ventricle, body
    B right atrium, right ventricle, lungs, left atrium, left ventricle, body
    C right atrium, lungs, right ventricle, left atrium, body, left ventricle
    D left atrium, lungs, left ventricle, body, right atrium, right ventricle

13. The part of the blood that is responsible for clotting is _____.
    A red blood cells
    B white blood cells
    C platelets
    D plasma

14. The kind of muscle found in the walls of the blood vessels is _____.
    A cardiac muscle
    B respiratory muscle
    C excretion muscle
    D nervous muscle

15. As an embryo develops, the cartilage in the skeleton is replaced by _____.
    A tendons
    B bone
    C ligaments
    D fat

16. The connective tissue that connects a bone to a bone is a _____.
    A ligament
    B skeletal muscle
    C nerve cell
    D tendon

17. What is the purpose of the small hairs in the nose?
    A to fight disease
    B to keep dust from the lungs
    C to tickle the nose and cause sneezes
    D They serve no purpose.

18. Humans, like fish, have a skeleton inside their bodies. What type of skeleton is this?
    A exoskeleton
    B nervous
    C respiratory
    D endoskeleton

19. Muscles that straighten out a joint are called_____.
    A flexors
    B cartilage
    C hinges
    D extensors

20. The largest internal organ in the body is the _____.
    A stomach
    B gall bladder
    C liver
    D appendix

21. Urine goes out of the body through what part?
    A ureters
    B urethra
    C kidneys
    D urea

22. The largest organ of the excretory system and of the entire body is the _____.
    A skin
    B kidney
    C liver
    D large intestine

23. How is the skin like an air-conditioning system?

24. What role does fiber play in the digestive system?

25. Bone and cartilage make up the human skeletal system. Compare and contrast these two materials.

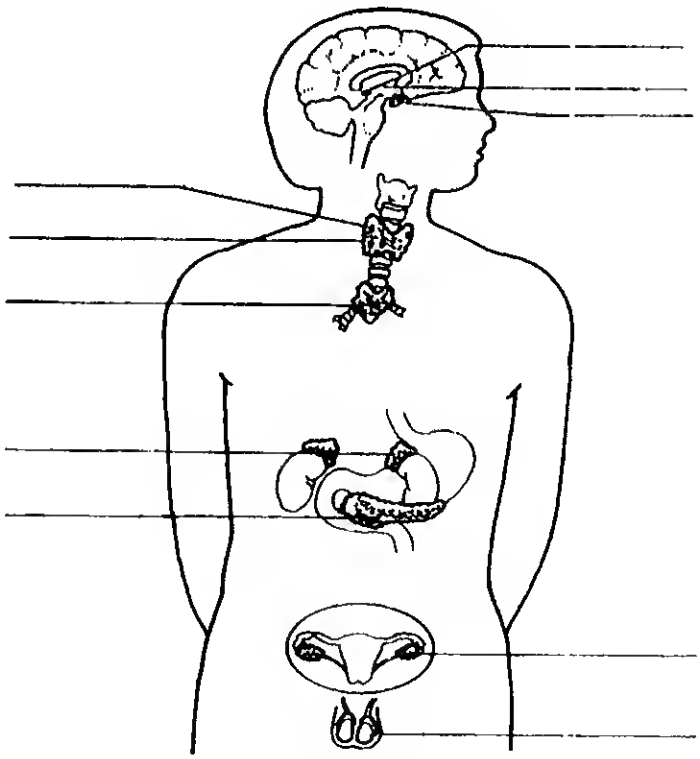
26. Name the advantages of an animal having an endoskeleton instead of an exoskeleton.

27. Vitamin D is needed for healthy bones. Your body can produce vitamin D if you are exposed to sunlight, which converts the vitamin inside your body. For this reason, vitamin D is sometimes called the "sunshine vitamin."

    What might happen to your bones if you did not receive enough sunlight?

28. Explain how the elbow joint operates with flexor and extensor muscles. Include a picture along with your explanation. Label your picture correctly.

29. Label the parts of the human endocrine system as shown in the diagram.



30. Insulin is made by which gland?
    A ovaries
    B pituitary
    C thyroid
    D pancreas

31. What body structure protects the lungs from outside harm?
    A alveoli
    B rib cage
    C diaphragm
    D cartilage

32. The white blood cells are responsible for which of the following?
    A clotting
    B fighting germs
    C transport oxygen
    D all of the above

33. Where are ***most*** of the nutrients from your food absorbed and sent into your blood-stream?
    A stomach
    B lung
    C large intestine
    D small intestine

34. What is the name of the muscle located below your lungs that assists in breathing?
    A heart
    B diaphragm
    C bicep
    D quadriceps

35. To which body system does human skin belong?
    A respiratory
    B excretory
    C cardiovascular
    D nervous

36. Which adaptation would ***not*** help an organism survive in the desert?
    A ability to conserve water
    B ability to hibernate
    C having a short life cycle
    D producing venom

37. Which of the following is a behavior triggered by a signal from inside the body?
    A running away
    B "freezing"
    C hibernating
    D eating

38. Which of the following is the universal signal from the environment?
    A sound
    B temperature
    C light
    D rainfall

39. Which of the following is an instinctive behavior?
    A a squirrel cracking a nut
    B a lion hunting a gazelle
    C a baby bird pecking at its shell
    D a young child riding a bike

40. Which of the following is ***not*** an inherited trait?
    A eye color
    B hair color
    C good grades
    D curly hair

41. Which of the following is an example of geographic isolation?
    A A plant dies after being transplanted.
    B An animal species is found on only one island.
    C An animal changes after being exposed to high levels of radiation.
    D A seed falls in a remote area of the Rocky Mountains.

42. The adaptations an organism makes to environmental stimuli can be essential to _____.
    A response
    B survival
    C conditions
    D influence

43. All members of a species that inhabit an area at the same time are a ____.
    A species
    B population
    C family
    D country

44. Adaptations that can be passed on do ***not*** include _____.
    A the basic structure of the organism
    B the reflex actions of the organism
    C how the organism carries out respiration
    D techniques for hunting food taught by the parents of the organism

CHAPTER 6
POPULATIONS AND ECOSYSTEMS

ORGANISMS AND THEIR ENVIRONMENT

Imagine you are standing in the Kibale Rainforest in Uganda, Africa. The Kibale Rainforest is a **habitat**, a place where organisms live. You spot a redtail monkey and decide to follow it home. You discover it lives with twenty other redtail monkeys. A group of redtail monkeys living in the same place at the same time is called a **population**. All living things exist in populations. That is, they interact with other organisms of the same kind. Some of these organisms are single-celled microorganisms. Others are multi-celled plants or animals. Even so, each distinct organism interacting with others of its kind is a population.

This redtail monkey is a member of a population.

Later that day, you follow the monkey as it searches for insects and fruit. You spot a blue monkey eating fruit from a tree. Next you see a grey-cheeked monkey eating a small mammal. You realize that the redtail monkey lives among many kinds of monkeys. It also coexists with tarantulas, fruit bats, mosquitoes, and many types of plants. These plants and animals living together in a defined area are called a **community**.

Ecology is the branch of science that studies how living things interact with one another and with their environment. All the plants and animals living in a given area, together with the nonliving parts of the environment, make up an ecosystem. Nonliving,

or **abiotic**, factors of an ecosystem include soil, water, climate, and sunlight. **Biotic** factors are all of the living things in the ecosystem. They include plants, animals and other living organisms. Ecosystems are typically self-sufficient and independent of other ecosystems.

ECOSYSTEMS

Around the world, you will find a variety of ecosystems. They can be as small as a puddle or as large as the Earth itself. Any **group** of living and nonliving things interacting with each other can be considered an **ecosystem**. The characteristics of each ecosystem are shaped by these interactions and by the physical environment. **Terrestrial** ecosystems are land-based ecosystems (grassland, forests, etc.). **Aquatic** ecosystems are water-based ecosystems (ponds, lakes, oceans, etc.).

Aquatic Ecosystems

ESTUARIES

An **estuary** is a partially enclosed body of water where seawater and fresh water meet and mix. Examples of estuaries include bays, mud flats, swamps, and inlets.

This estuary is a mixture of seawater and freshwater where many plants and animals reside.

Life in an estuary is influenced by the **rise and fall of the tides**. Mammals, birds, fish, reptiles, shellfish, and plants all live and interact in this ecosystem to create very complex **food webs**. The soil, sand, and mud in an estuary are full of rich decaying matter in which plants thrive. During the day, when the tide is out, creatures such as clams and oysters close their shells for protection. Crabs and small fish hide from predators. Some animals, like birds, are active during the low tide in the daytime because the supply of food is easier to get to. At night when the tide returns, the estuary comes alive. Many estuary creatures are active only at night. The returning seawater floods the estuary bringing protection from predators.

Estuaries also act as **natural buffers** between the land and the ocean. Like barrier islands, they protect the mainland and people from the major force of heavy storms. Hurricane Katrina's extensive damage to New Orleans was partly due to buffers being removed by developers.

SALT MARSHES

Salt marshes occur in places where the land meets the sea, such as barrier islands and other coastal areas. The marshes are exposed to water at different times of the day or year. Sometimes the marsh has little water, and sometimes the marsh is full. The **salinity,** or salt content, of a marsh depends on whether it is located close to the ocean or further upstream in the estuary. The water level and salinity level determine which plants and animals make their homes there.

Many young animals can hide in the tall grasses of a salt marsh.

Microscopic organisms like bacteria, fungi, and algae make their home in the decaying marsh grasses. Animals like oysters and clams that filter-feed live here because of the availability of plankton. Fish and crabs move through the marsh at high tide. Birds and predatory animals visit at specific times for their catch. The plants of the salt marsh provide shelter from predators, especially for young animals who use the salt marsh as a nursery.

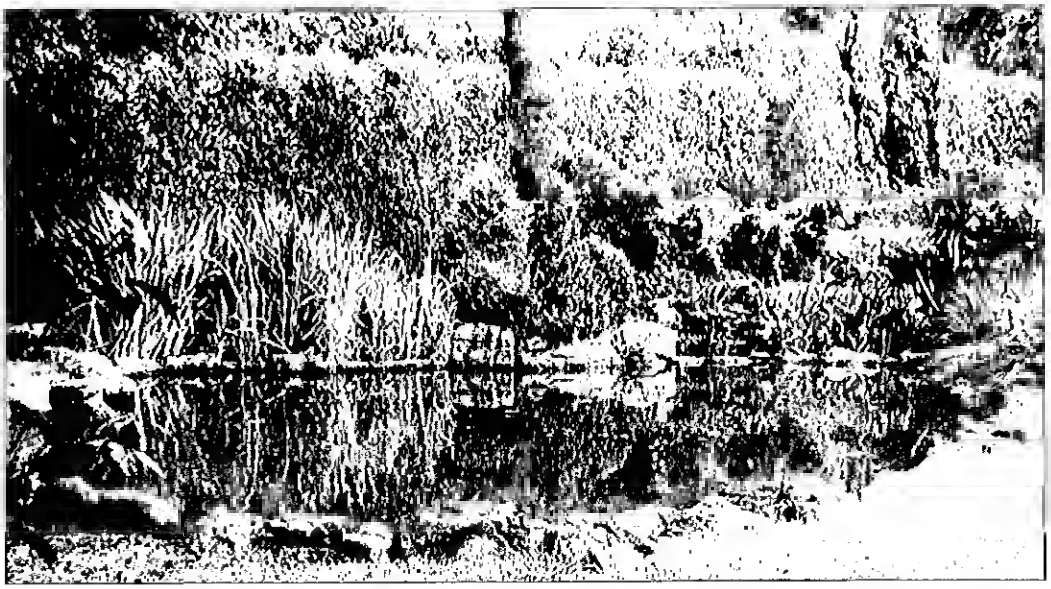
OCEANS

Oceans cover three-quarters of the Earth's surface. This huge ecosystem is a self-contained world with a complex food chain in which many organisms have adapted to extreme and unusual conditions. The ocean is home to the smallest plankton and the largest creature on Earth, the blue whale.

When you are at the beach looking at the ocean, it is easier to imagine its immense size.

PONDS

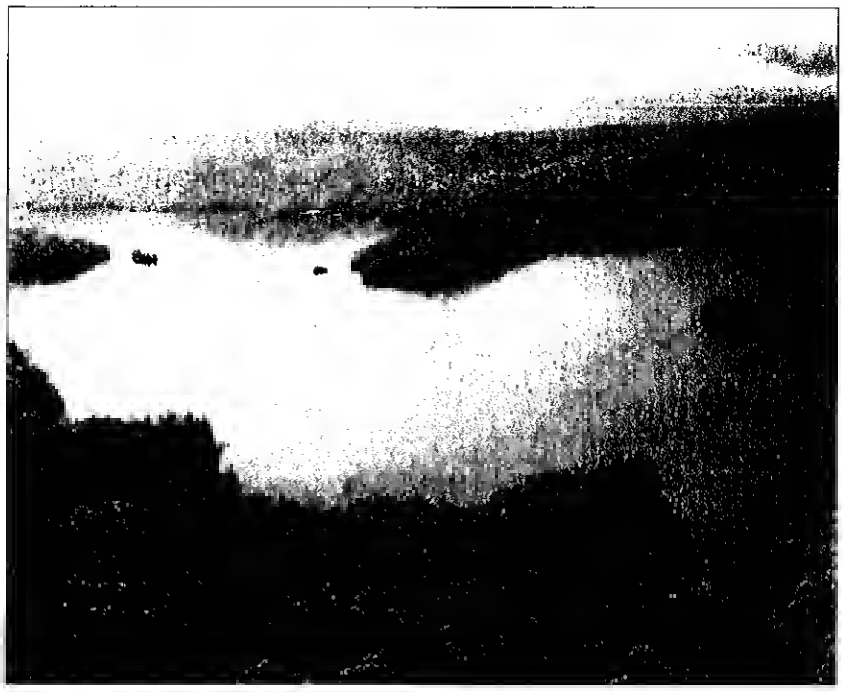
A **pond** is a body of water shallow enough to allow plant roots to reach the bottom. Plants such as cattails may grow in the pond as well as around the perimeter. The temperature of a pond remains the same from top to bottom, and few waves are found here.



Notice how motionless the water is in this small pond.

LAKES

A **lake** is bigger than a pond, and is **too deep** to support plant roots except near the shore. Some lakes are big enough for waves to be made. Unlike a pond, the temperature of the water in a lake during the summer is not the same from top to bottom. The water is warmer near the top of the lake. Because of this, most of the creatures found in a lake are in the top layer.

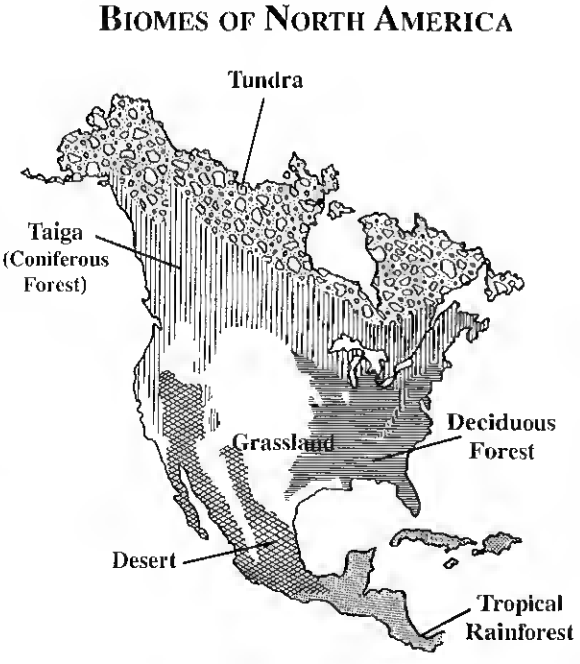


Many lakes are large and have swimming areas and campsites for tourists.

Animals that feed on fish and other smaller animals who visit lakes and ponds inhabit the areas around these bodies of water. At times, large trees and scrubs may also grow around the edge and provide food and shelter for other animals in this ecosystem.

BIOMES

The **biosphere** is the part of the Earth where life exists. It consists of the thin envelope around the Earth made up of atmosphere, land, and water. It is characterized by large regions that can be identified by the types of plants and animals that live there. These regions making up the biosphere are called **biomes**. Biomes are similar ecosystems throughout the world grouped together. A number of climactic factors interact in creating a biome. In places where precipitation is moderately abundant and distributed fairly evenly throughout the year, the major factor in determining the biome is **temperature**. This includes not just the average temperature, but things such as the length of the growing season and whether or not it ever freezes. Based on these factors, there are four biomes that extend from the extreme latitudes with low temperatures to the tropics with very warm temperatures. These are the tundra, taiga, deciduous forest, and tropical rainforest. Other biomes are controlled not so much by



Notice the variety of biomes on our continent.

temperature but by the amount and distribution of **rainfall**. The prevailing winds in the western half of North America blow in from the Pacific Ocean filled with moisture. Each time this air rises up from the western slopes of the mountains, it expands and cools. Its moisture condenses and falls on the mountains as rain or snow. When the winds reach the eastern slopes, there is little moisture left. This pattern describes the biomes of the grasslands and desert.

Terrestrial Ecosystems

DECIDUOUS FORESTS

A forest is an area with a high density of trees. One of the most interesting features of a **deciduous forest** is the way it changes with the seasons. This happens because of the process of **photosynthesis** which allows trees to capture energy from the sun and use it to grow. As the chlorophyll in the leaves breaks down, the colors of the leaves are exposed and the leaves change color. To survive the long winters, trees become dormant and drop their leaves. When spring arrives and the days become warmer, the process of photosynthesis begins the cycle again.

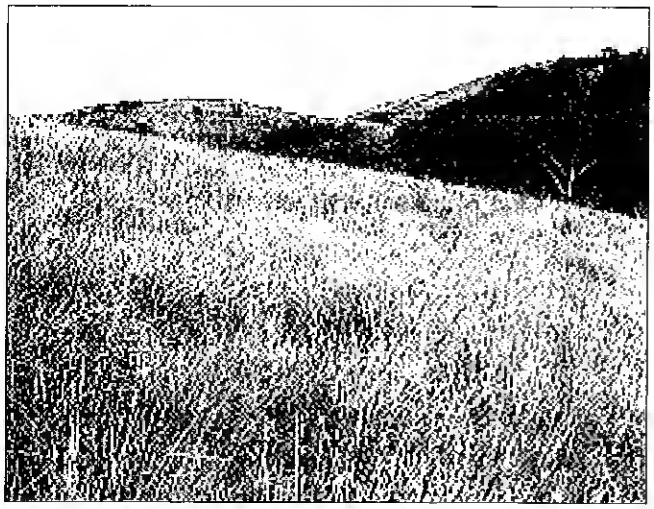
Forests provide food and shelter for many animals.

Animals that live in forests use the trees and underlying plants as **food or shelter.** Deer, hawks, mountain lions, raccoons, and foxes are all able to live in the same ecosystem because they each have different needs. This helps to maintain the balance in their environment.

GRASSLANDS

Grasslands are big open spaces with only a few bushes and trees that are found by rivers and streams. These grasslands seem like endless seas of waving grass. They are often found between forests and deserts. The amount of rainfall that occurs in a grassland is a major factor in its maintaining its characteristics.

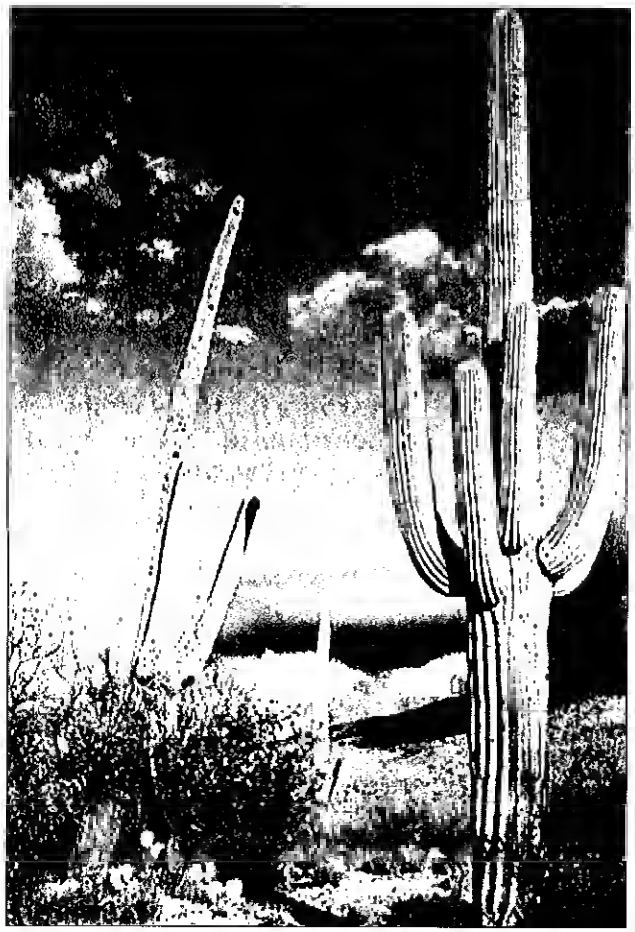
Soil in the grasslands is fertile. Crops grow well here. Plant roots grow deep into the soil. At one time in the United States, open prairies were home to herds of buffalo who roamed the open ranges. In grasslands in other parts of the world, herds of grazing animals such as zebra and antelope live in packs. These packs provide protection for these animals that are unable to hide from predators in the expansive grasslands.



Grasslands seem like endless seas of waving grass.

DESERTS

The **desert** is a land of extreme heat and dryness. Temperatures in excess of 100 degrees Fahrenheit are common. At night, the temperatures fall into the 40s or 50s. There is very little humidity in the desert.



When driving through a desert, many cacti are seen across the landscape.

Desert plants often look different from other plants. One of the most common desert plants that you all have seen is a cactus. Adaptations allow these plants to live in this environment. They have the ability to collect and store water. Features that reduce water loss often account for their unusual appearances. Cactus, for example, is prickly. This stops animals from eating them and is a type of water-loss protection.

Animals that live in the hot desert have adaptations as well. Some animals never drink, but get their water from seeds and plants. Many animals are nocturnal, sleeping during the hot day and only coming out at night when it is cooler to eat and hunt. Some animals rarely spend any time above ground. They live and search for food in underground burrows where the temperature is much cooler.

TUNDRA

The **tundra** is located at the top of the world near the North Pole. The frigid cold and deep snow makes life in the tundra very difficult.

The most distinctive characteristic of tundra soil is **permafrost**, a permanently frozen layer of ground. The ground may briefly thaw during the short summer allowing lichens and other small compact plants to grow. However, during most times of the year, plants are dormant.

When the permafrost refreezes after a short summer, nothing grows.

Caribou can adapt to the harsh conditions of the tundra.

In order to survive, every animal living in the tundra must adapt to the harsh conditions. Some grow thick fur which turns white in the winter to keep them warm and to camouflage them from predators. Others find a place to hibernate during the cold winter months.

A wolf's fur turns white in the winter to camouflage it on the snow.

TAIGA

South of the tundra is the **taiga**. This is an area of dense evergreen forests of coniferous trees. These evergreen trees include spruces, cedars, and firs. There are a few small berry-bearing shrubs, lichens, and mosses among the trees.

In the winter, coldness and food shortages make life difficult. Some animals hibernate, and others fly south if they can. The average temperature is below freezing for six months out of the year. Winters are very cold (-65° to 30°F) with lots of snow.

Summers are very short with temperatures ranging from 20°F to 70°F. They are warm, rainy, and humid. There are millions of insects, and insect-eating birds migrate here to nest and feed.

Most animals of the taiga are predators such as lynxes, bobcats, and wolverines which hunt voles, squirrels, and rabbits. There are also deer, elk, and moose living in certain parts of the taiga.

Moose find lush grazing areas near the evergreen forests.

TROPICAL RAINFOREST

The trees of a tropical rainforest are very dense due to the enormous amount of yearly rainfall.

The **tropical rainforest** is in the extreme south near the equator and receives plenty of rainfall all year long. An average of 50 to 260 inches of rain falls yearly. Since temperatures are always warm to hot, an incredible variety of tall trees and many species of plants, such as orchids, grow in this region.

Rainforests cover less than 6% of the Earth's land surface, but produce 40% of the Earth's oxygen. About one-fourth of the medicine used comes from rainforest plants.

Many species of animals such as sloths, monkeys, and jaguars live in the rainforest. Mammals and birds have adapted to a life in the trees. Many have bright colors, loud vocal calls, and live on fruits. Reptiles such as boa constrictors and anacondas also thrive in this area.

Insects are the largest group that lives in the rainforest. There are butterflies, mosquitoes, and huge colonies of ants.

Many brightly-colored birds can be seen and heard in the rainforest.

PRACTICE

1. Bruce is visiting an ecosystem/biome where the land is dry, the temperature is 100°F, and there are few plants or trees. Bruce is ***most likely*** visiting _____.

2. Life in an estuary is influenced by the rise and fall of the tides. Explain why this is so.

3. Complete the chart below with the name of the ecosystem/biome based on the characteristics provided.

Ecosystem/Biome	Temperature	Moisture	Plants	Animals
_____	Cold	Dry	Lichen	Caribou
_____	Hot	Dry	Cactus	Jackrabbit
_____	Moderate	Wet	Marsh grass	Crabs and fish
_____	Hot	Dry	Grass	Zebra
_____	Hot	Wet	Orchids	Sloth

4. An estuary is a partially enclosed body of water where seawater and freshwater meet. What are some examples of estuaries?

5. What is the difference between a pond and a lake?

6. Explain the difference between a population, a habitat, and a community.

7. What elements might you find in a beach community?

8. What elements might you find in a mountain community?

9. What is ecology?

10. Explain the difference between abiotic and biotic factors.

11. Deserts and tropical rainforests may both occur in hot areas. How are the plants in these biomes different?

12. What are ecosystems? What is the difference between an aquatic and a terrestrial ecosystem? What are biomes?

13. Explain the importance of a salt marsh.

14. Explain the changing of the seasons in a deciduous forest.

15. How do animals in the desert adapt?

16. What is permafrost?

17. How do animals in the tundra adapt?

18. How do animals adapt in the taiga during the winter?

19. Why is the taiga a good place for feeding and nesting during the summer for certain species of birds?

20. Why are the tropical rainforests important to mankind?

ORGANISMS IN ECOSYSTEMS

There are many types of **interactions** between the different organisms of an ecosystem. Most of these interactions are beneficial. For example, plants provide green leaves for caterpillars to eat. In turn, when the caterpillars change into butterflies, they help plants grow by pollinating flowers. This is how an ecosystem works.

A pond ecosystem can support itself.

However, **ecosystems** are not lush gardens of unlimited resources. There is fierce competition for food, space, and mates. For example, a redtail monkey will fight off other redtail monkeys to secure and keep a territory for its family. This is because redtail monkeys eat the same kind of food. A given space may have enough food for one family, but not two or three. Too many families might cause all the monkeys to starve. In addition, the male who successfully defends a territory is more likely to secure a mate.

On the other hand, redtail monkeys do not have to worry about the grey-cheeked monkeys sharing their ecosystem. This is because the grey-cheeked monkey eats a different type of food. It spends most of its time on the forest floor in search of small animals. The forest floor is the grey-cheeked monkey's ecological **niche**. A niche is an organism's "address" in the community. It defines where an animal lives, what it eats, and what it gives back to the ecosystem.

Another example of sharing are hawks that also live in ecological niches. The size of a hawk's prey is determined by the hawk's body size. Larger hawks search for large prey, and smaller hawks look for small prey. For this reason, hawks with different body sizes can live in the same area. When food sources do not overlap, different kinds of birds and animals can live together in the same ecosystem.

This large hawk looks for larger prey while smaller hawks living close by look for smaller rats and rodents.

THE TRANSFER OF ENERGY

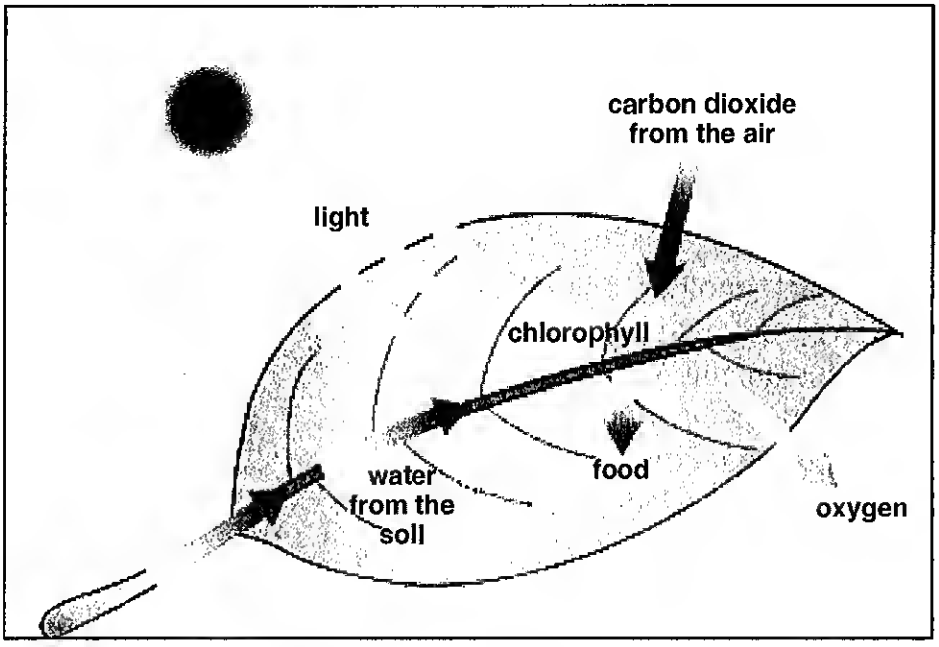
Producers

All living things within an ecosystem share a common need. Every single organism depends on the **sun** for survival. In fact, there would be no life at all if it were not for the sun. Plants need energy from the sun to grow and reproduce. These are called **producers**. Animals get energy from the sun indirectly, either by eating plants or by eating animals that eat plants and are called **consumers**.

Plants trap energy from the sun in specialized plant cell compartments called chloroplasts. **Chlorophyll**, a green pigment found inside chloroplasts, converts light energy from the sun into usable chemical energy. This process is called **photosynthesis**. This chemical energy, stored in the form of starch, is used by the plant to build new tissue. Because plants produce their own energy, they are called **producers**.

Plants are warehouses of the sun's energy. Think about a campfire. Its burning wood gives off light and heat. Light and heat are the release of energy trapped in the wood, or plant tissue—energy that originally came from the sun. Coal and oil are similar forms of the sun's energy trapped and stored by plants. Coal and oil are both fossil fuels made over time from many layers of dead plant material. Over millions of years, these plant

deposits were pressed together, causing them to change form. The result is a concentrated form of energy—coal or oil. Today, we use this energy to fuel automobiles, to make electricity, and to power cargo vehicles headed to the International Space Station.



Plants make their own energy.

Consumers

Remember that producers are able to make their own energy. They do not rely on other organisms for food. Animals are different. They must find and consume their food. They get their energy by eating plants or by eating other animals that eat plants. For this reason, animals are called **consumers**. There are two levels of consumers—the **primary consumer** and the **secondary consumer**. An animal that eats only producers (plants) is called a primary consumer (plant eater). An animal that eats a primary consumer is called a secondary consumer (meat eater). Secondary refers to the fact that this organism is removed from the original source of energy—the plant.

A rabbit is both a primary consumer and an herbivore.

There is a second way to distinguish among consumers. Consumers that eat only plants are called **herbivores**. White-tailed deer, rabbits, and snails are examples of herbivores. Herbivores feed directly on green plants. **Carnivores** are animals that eat only other animals. Coyotes, lions, and skunks are examples of carnivores. The third category of consumer (tertiary) is the **omnivore**. Omnivores eat both plants and animals. Humans, brown bears, and pigs are examples of omnivores.

The Predator-Prey Relationship

An animal that eats another animal is called a **predator.** A predator surprises, kills, and then eats another animal. The animal that is eaten is called the **prey**. Humans are the most successful predators on Earth. For example, every year during deer season, humans hunt and kill thousands of deer.

A predator kills and eats its prey.

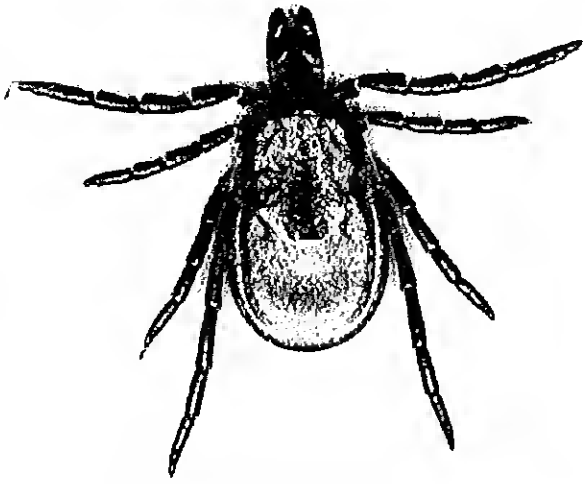
Hunting plays an important role in balancing the ecosystem. It helps keep a community in balance. For example, if humans stopped hunting deer, the deer population would grow unchecked. The deer would eat all the plants. Other herbivores like rabbits would starve and that particular ecosystem would be in danger.

Decomposers

When animals die, their bodies return to the soil. **Decomposers** are organisms in the soil that break down this matter into simple nutrients. These simple nutrients are then used by plants to grow. Fungi, such as mushrooms, and bacteria are examples of decomposers. Decomposers are the **recyclers** of ecosystems.

Symbiosis

Symbiosis is a relationship in which two species live closely together. One type of symbiosis is **mutualism**. In mutualism, both species benefit from the relationship. For example, many flowers depend on insects to pollinate them. The insects are provided nectar and pollen by the flowers, and the flowers are provided a means for reproduction by the insects.



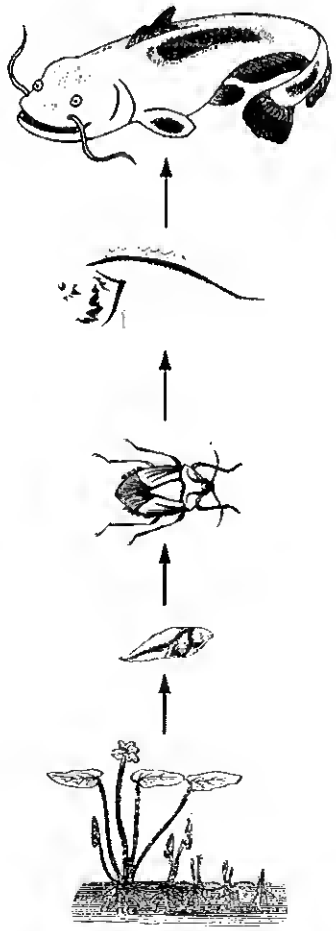
A tick is a parasite that may cause illness in humans or animals.

A flower and a bee have a symbiotic relationship.

Another form of symbiosis is parasitism. A **parasite** is an organism that lives inside or on another organism called a **host**. The parasite depends on the host for some or all of its nourishment and often causes some harm to the host. Parasites come in many forms. Mistletoe is a plant parasite that lives in trees. Mosquitoes, ticks, and mites are parasites that may cause illness in humans and animals. Viruses are an example of parasites that can only survive and reproduce within other living organisms.

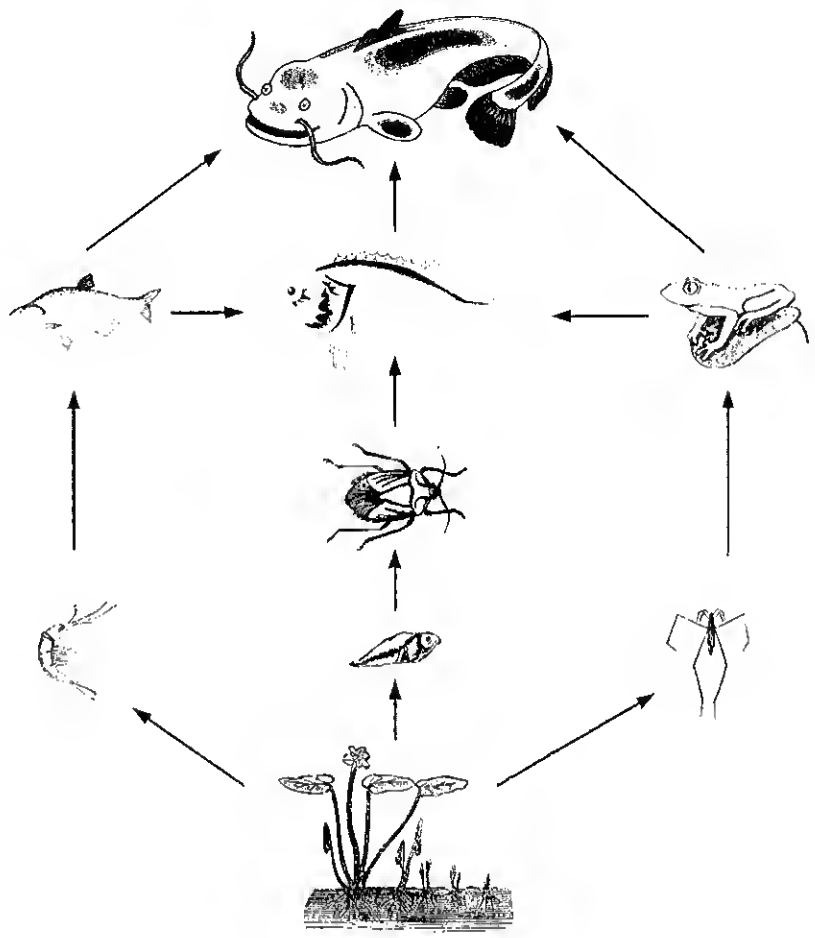
Food Chains and Food Webs

In this ecosystem to the right, **energy** passes from producer to consumer in a series of ordered steps. The aquatic plant is the first step. It is eaten by a primary consumer, the tadpole. The tadpole is eaten by a secondary consumer, the water beetle. The water beetle is eaten by the perch which, in turn, is eaten by the catfish. The catfish excretes waste which falls to the bottom of the lake. This waste is converted by a decomposer, the snail, into simple nutrients. These nutrients are then used later by another aquatic plant, and the cycle continues. All of this is possible because of the energy the plant takes in from the sun.



The food chain in the ecosystem of Jordan Lake

The series of ordered steps is called a **food chain**. This simple food chain shows only one possible food source for each organism. But in reality, feeding relationships are much more complex. Most plants and animals are members of many different food chains. A **food web** shows the relationship of an organism to more than one member of an ecosystem. The food web below, although simplified, shows how the plants and animals are interrelated.



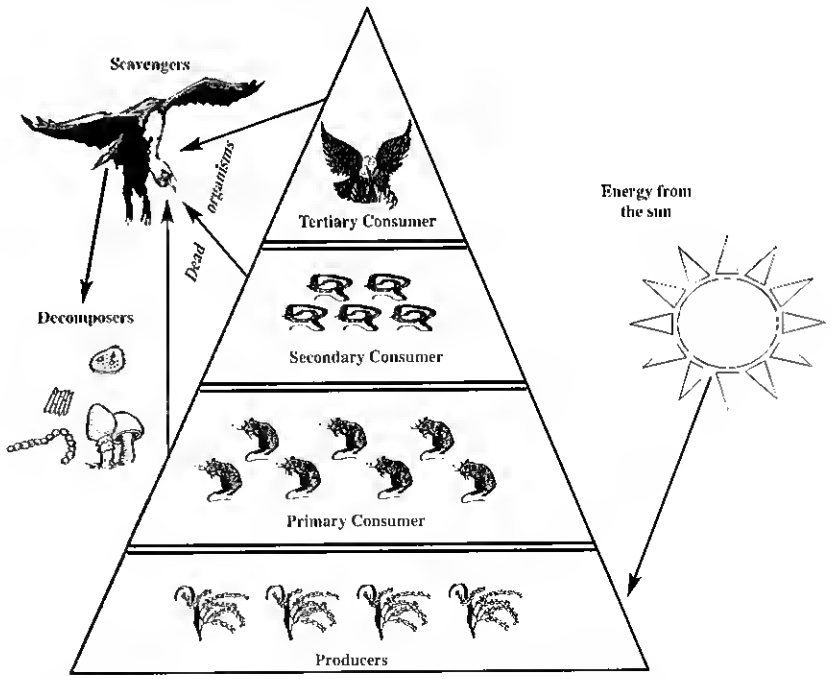
The food web

A food web includes many different organisms. At the base of this food web is the producer, or aquatic plant. The plant is eaten by several small animals and these, in turn, are eaten by bigger animals like roaches, beetles, and frogs. At the top of the food web is the catfish. It gets energy, either directly or indirectly, from all of the members below it. If one organism is removed, other organisms may be endangered or possibly die out.

Related to the idea of a food web is the concept of **carrying capacity** which is the number of individuals in a population that the resources of a habitat can support. This provides for a balanced ecosystem. The living things in an ecosystem can be divided

into four levels. Each step in a food chain or food web is called a **trophic level**. Producers are the first step. Consumers are the next steps. Each step depends on the step below it for food to provide its energy.

1. **Producers** are the green plants and some bacteria and alga that are able to make their own food from water, the sun, carbon dioxide in the air, and minerals in the soil. Remember when plants make their own food they use sunlight, and it is called photosynthesis.
2. **Consumers** are the animals that rely on other organisms for food. This group can be further divided into three groups:
   a. *Primary consumers* are **herbivores**, or plant eaters. Examples are certain insects, deer or mice.
   b. *Secondary consumers* are **carnivores**, or flesh eaters. They feed on herbivores. Examples are snakes and coyotes.
   c. *Tertiary consumers* can be carnivores or **omnivores** which eat both plants and animals. Examples include hawks and humans.
3. **Scavengers** feed on dead organisms. They include earthworms, ants, and vultures.
4. **Decomposers** are organisms that break down dead organic matter. This decomposition produces many of the raw materials that are used by the producers in photosynthesis. Decomposers include bacteria and fungi.



The energy pyramid shows the transfer of energy from one level of the food chain to another.

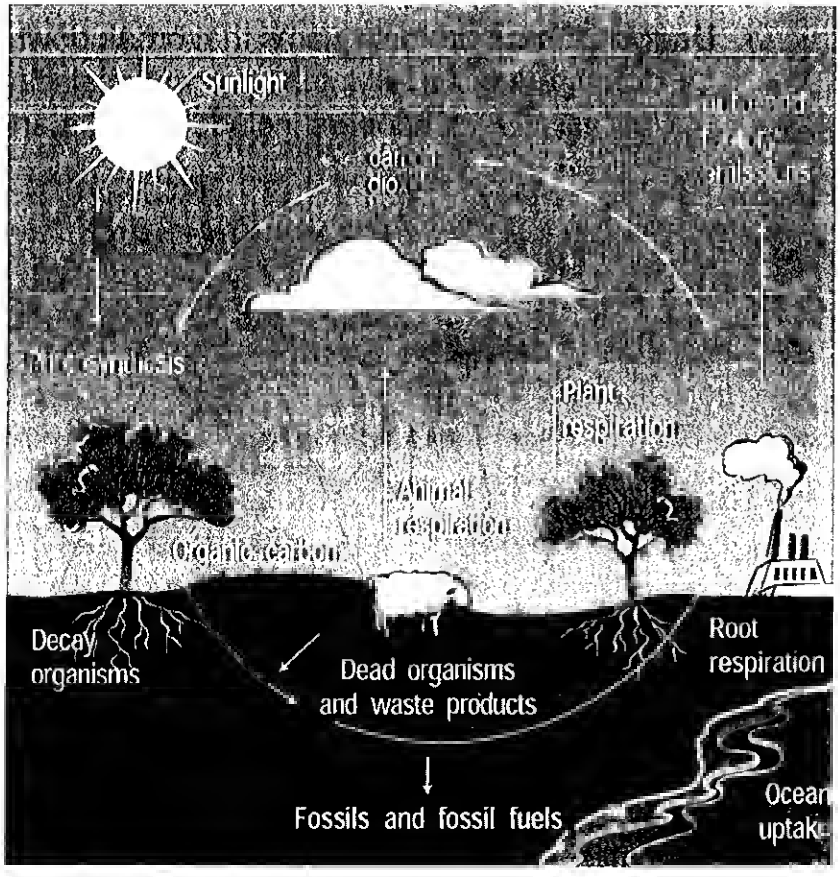
Ecological pyramids are diagrams that show each trophic level in a biome. One type is the energy pyramid. The **energy pyramid** shows the transfer of energy from one level to the next. The bottom of the food chain shows the largest amount of energy which comes from the sun. Then as you move up, energy is used but also lost in the form of heat energy.

HOW MATERIALS ARE RECYCLED IN NATURE

The **biosphere** is the part of the Earth where life exists. It consists of the thin envelope around the Earth made up of atmosphere, land, and water. It is characterized by large regions that can be identified by the types of plants and animals that live there. The biosphere has elements that are constantly used and reused in ecosystems. They are carbon, hydrogen, oxygen, and nitrogen and are provided in cycles so they can be used and then reformed to keep the elements constant in our environment.

Carbon Cycle

Carbon is an element found in nature. It is found in diamonds, gasoline, and pencil lead. Carbon is one of the elements which cycles through nature. The **carbon cycle** provides carbon, an element present in every living organism. Carbon is in our atmosphere in the form of carbon dioxide. In organisms, carbon dioxide is breathed out in respiration and is released into the atmosphere in the decomposition of dead plants and animals. Plants use carbon dioxide in photosynthesis and make sugars and oxygen. Some of these sugars are stored in the tissues of plants, and others are used by the plant for energy.

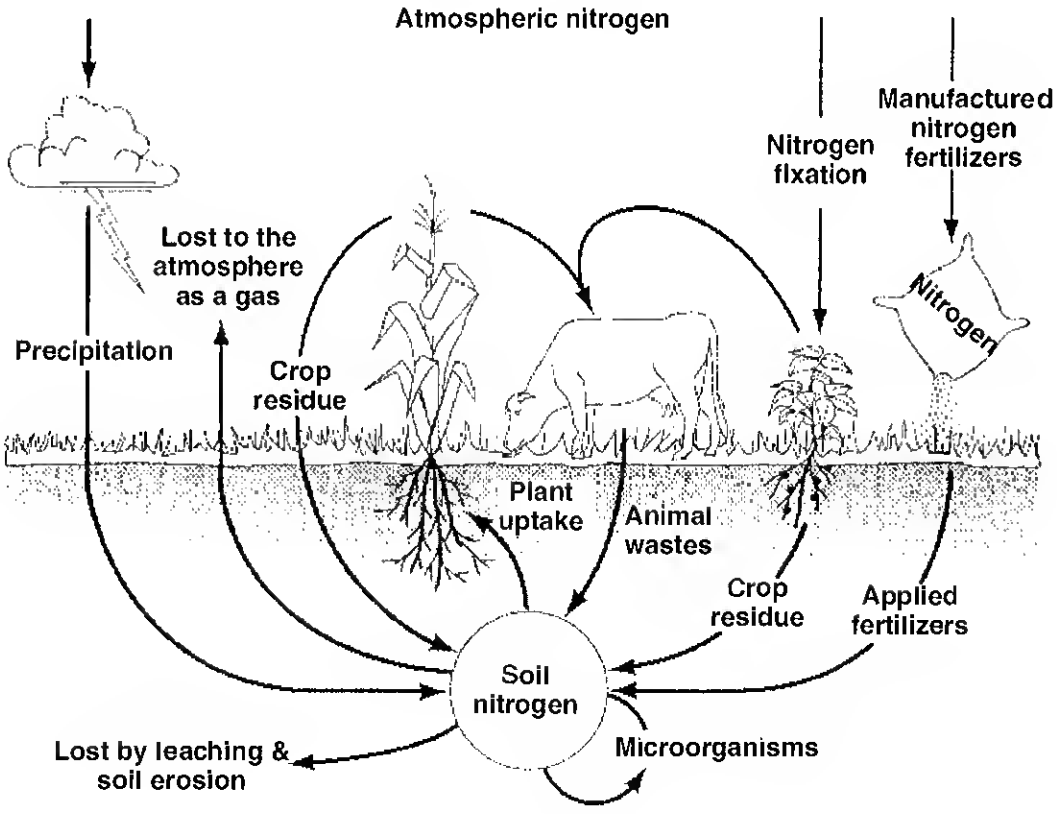


The carbon cycle describes how carbon moves through living things and the environment.

When a plant is eaten, the animal's cells break down the plant's tissues during digestion. This releases the carbon that was stored and other nutrients into the animal's body. The carbon dioxide that is released into the air is used by plants during photosynthesis, and the cycle then repeats itself.

The Nitrogen Cycle

The nitrogen cycle is needed to supply amino acids which are the building blocks of proteins and necessary for plant growth. Nitrogen gas is 80% of our atmosphere. Some organisms can only use nitrogen in the form of ammonia. When nitrogen in the air is converted to ammonia, it is called **nitrogen fixation.** Some bacteria convert nitrogen on plant roots so that nitrogen is eaten in the plant and the consumers who eat the plants use it to make protein. Nitrogen is also found in our waste products and in decaying matter. When organisms die, decomposers return nitrogen to the soil in a process called **decomposition** to start the cycle again.



The nitrogen cycle

Without these cycles, living things could not survive. In nature, these materials needed by all organisms in an ecosystem must be reused or recycled to keep the ecosystem thriving.

Practice

1. Can you think of another animal that is even higher up in the food web than the catfish?

_____

2. Which organism in each food chain below is the primary consumer? (Circle one.)
   flower → insect → bird
   shrub → deer → man

3. Which organism in each food chain below is the producer? (Circle one.)
   grass → rabbit → fox
   sea plant → fish → bird

4. Which organism in each food chain below is the secondary consumer? (Circle one.)
   grass → mouse → cat
   sea plant → fish → seal

5. Name the predator in each of the six examples above.

   1. _____

   2. _____

   3. _____

   4. _____

   5. _____

   6. _____

6. Name the prey in each of the six examples above.

   1. _____

   2. _____

   3. _____

   4. _____

   5. _____

   6. _____

7. Are the animals below herbivores, carnivores, or omnivores? Write your answer in the space provided.
   a. fish that eat insects and plants _____
   b. spiders that eat insects _____
   c. bears that eat fish and honey _____
   d. people who eat steak and potatoes _____
   e. people who eat only plants (vegetarians) _____
8. Why are interactions between organisms in an ecosystem important?

   _____
9. What is a niche?

   _____
10. Why is the sun important?

    _____
11. How does hunting play an important role in balancing the ecosystem?

    _____
12. What are decomposers, and what is their job?

    _____

    _____
13. What is symbiosis?

    _____
14. Explain mutualism and parasitism.

    _____

    _____

15. What is a food chain?

16. What is a food web?

17. What are the four trophic levels in a food chain or food web. Explain each.

    1.

    2.

    3.

    4.

18. Make your own energy pyramid in the space below.

19. Explain the carbon cycle.

20. Explain the nitrogen cycle.

21. Why are cycles important in an ecosystem?

22. What is the difference between a primary consumer and a secondary consumer?

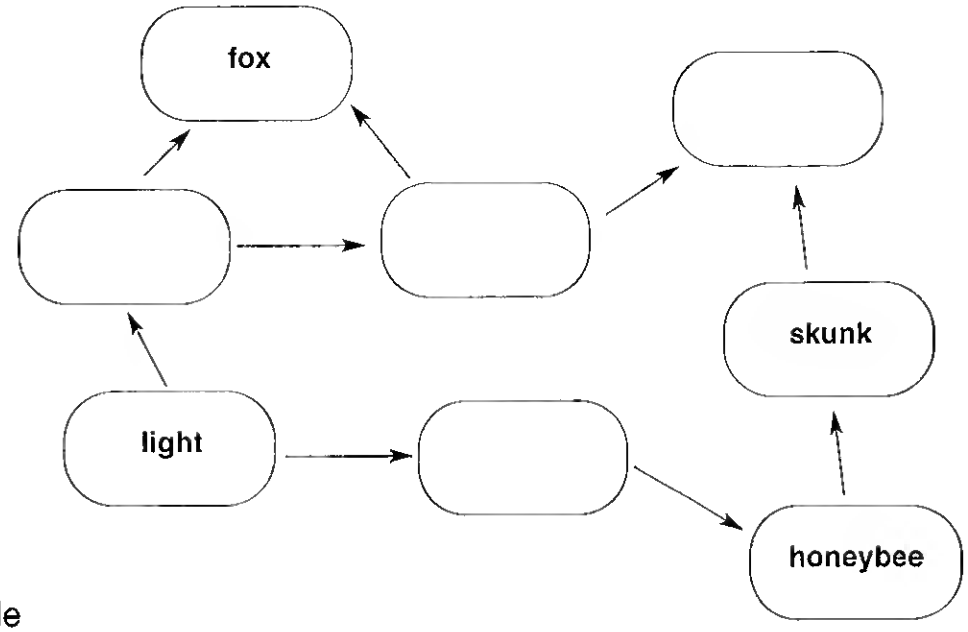
23. What is a producer? Give an example.

24. Write an example of a predator-prey relationship. Be sure to indicate which is the predator and the prey.

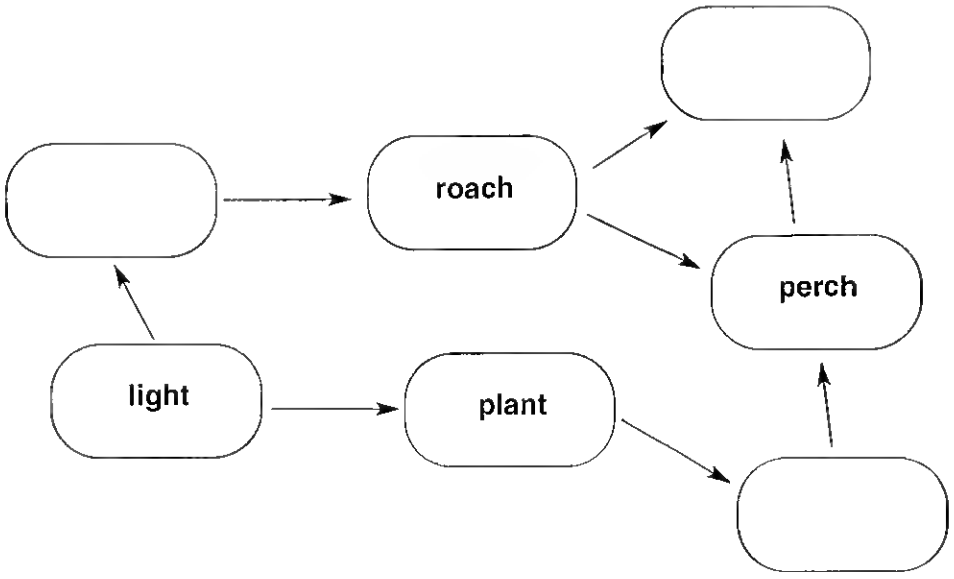
25. Why are decomposers important to the ecosystem?

Fill in each circle of the food web below with the correct number of the plant or animal from the list. The arrows point from the energy provider to the energy user.

26. 1. hawk
    2. rose
    3. plant
    4. rabbit



27. 1. tadpole
    2. catfish
    3. plant

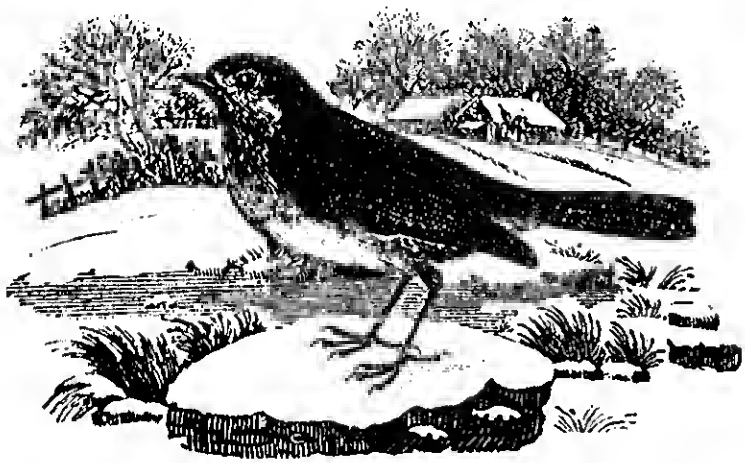


FACTORS THAT CONTROL POPULATIONS

Nature has a way of limiting populations to a certain manageable size. Without these natural population controls, rivers would be choked with fish, and the air would be smothered with insects. In order to survive, organisms must contend with both living and nonliving factors in their environment. Both sets of factors determine how large populations can grow.

Living Factors

Living, or **biotic** factors include such things as food (plants and animals), trees, competition for mates, and the presence of predators. For example, male robins establish themselves in a territory where there is enough food to raise their young. The size of their territory changes from year to year. If food is plentiful one year, a small territory will contain enough food to meet a robin's needs. If food is scarce, a larger territory will be required.



A male robin sings to warn competitors and attract a mate.

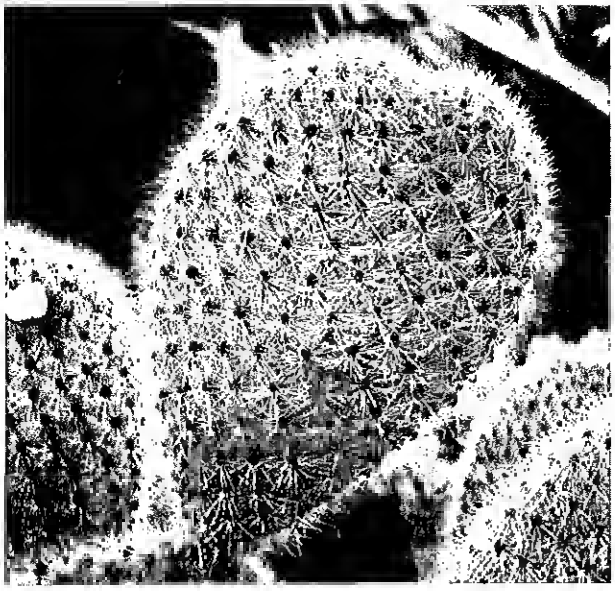
Male robins advertise ownership of a territory by singing. This is their way of warding off competing males. Occasionally, a new aggressive male will put up a fight in an attempt to chase the established male away and steal his territory. The robin's song also attracts mates. Female robins will not mate unless they are in a protected area with a stable food supply.

Another living factor in the robin's environment is the presence of predators. Robins must be alert for birds of prey, such as hawks. In addition, snakes and other birds may invade their nests to steal their eggs or eat their young.

Nonliving Factors

Ecosystems are characterized by certain soil and climate conditions and a particular grouping of plants and animals. All kinds of organisms cannot live in every ecosystem. Organisms have adapted to different conditions so that they can survive.

There are various **nonliving**, or **abiotic** factors that affect an ecosystem's ability to sustain life. The main factors that change in various ecosystems are space, light, weather, temperature, soil composition, and water availability. These abiotic factors are called **limiting factors** because they control the growth or survival of a population. Anytime one or more of these factors is changed, the life forms supported by that ecosystem change. For example, the leaves of a cactus are spines to prevent a great amount of water loss, its stems store water during dry spells, and its shallow roots absorb any water quickly. Rodents that live in the desert have kidneys that help conserve water, and they can get water from the food that they eat. In rainforests, plants have thin, long leaves with pointed tips that help to shed excess water.



A cactus has the capability to store water for dry spells.

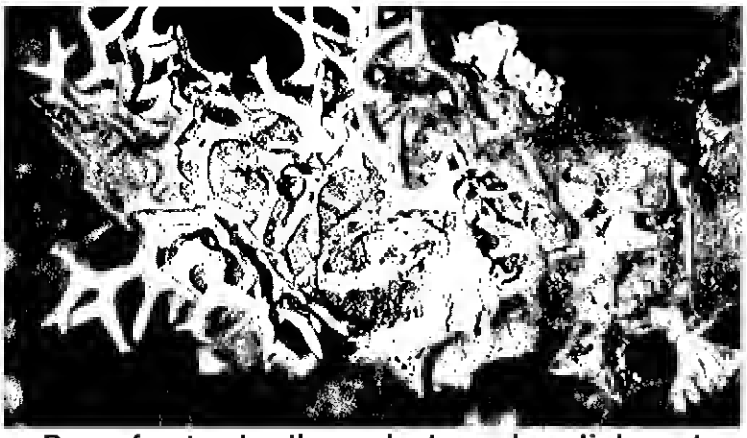
Life on Earth depends on the energy from the sun.

Sunlight is the main energy source for life on Earth. Because light is required for photosynthesis, it is very important in the productivity of an ecosystem. Some plants require abundant sunlight to grow, while others can survive in full shade or greatly reduced sunlight. For example, in the rainforest, the leafy tops of the tall trees shade the second layer of shorter trees and vines where orchids are abundant.

Like light, **temperature** can greatly affect the types of producers and consumers that are in an ecosystem. Plants and animals in New Mexico can withstand temperatures that range from extremely hot to below freezing. Rainforest plants would die quickly if temperatures were to drop below freezing. Animals in the tundra migrate, hibernate, or grow a winter coat that can withstand the harsh, cold conditions.

Soil composition is also important to an ecosystem. Areas that have nutrient-rich soil are typically able to support a variety of producers. For example, grasslands have fertile soils that sustain lush grasses and herbs that are home to many herbivores, birds, and reptiles.

Permafrost in the tundra allows only mosses, lichens, and short grasses to grow. Only a few migratory birds and mammals, musk oxen, foxes, and caribou can withstand the harsh conditions in the tundra.



Permafrost only allows plants such as lichens to grow in the tundra.

Think of a world with water shortages and all its effects.

Water is another important factor in what lives in an ecosystem. All organisms must have water to survive. Animals and plants that live in a desert must be able to survive with little water. Forests in seasonably dry areas will shed their leaves to conserve water until the rain returns in the spring. Plants and animals have adapted to where they live. A cactus would rot and die in a rainforest, and a rainforest frog would die in a desert.

All of these factors play an important role in the survival of an ecosystem. Look at how all of these factors would affect trees in the Great Smoky Mountain National Park. Tall trees soak up sunlight and prevent any light from reaching the forest floor. It is then hard for small seedlings to grow because they get inadequate sunlight. However, if a storm knocks down a tall tree, a clearing is opened up. Light bathes the clearing and soon there is a desperate competition among immature plants to claim this **space**. Usually the fastest growing tree wins. The prize is sunlight, survival, and the chance to reproduce. For these plants, space, light, and the storm that knocked down the tree are nonliving factors which affect their populations.

Trees in a forest must also contend with drought, recurring fire, and many other climate-related factors. Because animals are dependent upon plants, their populations are strongly affected by these nonliving factors. The changing seasons as well as water and air quality also affect the populations of plants and animals alike.

What would happen to the forest and its inhabitants if lightning started a fire?

PRACTICE

1. List three examples of nonliving factors in an ecosystem.

   1. _____

   2. _____

   3. _____

2. Is it a living or a nonliving factor in the environment? Write your answer in the space provided.

   a. space _____

   b. predators _____

   c. mates _____

   d. food _____

   e. rainfall _____

   f. competitors _____

   g. fire _____

   h. sunlight _____

3. Explain how each of the following determines an ecosystem's capacity to support life.

   a. light _____

   _____

   b. temperature _____

   _____

   c. soil composition _____

   _____

Chapter 6 Review

1. A group of individuals of the same species that occupies a given area at the same time is a/an _____.
   A organism
   B population
   C community
   D ecosystem

2. In areas where the land meets the sea in coastal areas, _____ are common.
   A salt marshes
   B freshwater ponds
   C mud
   D rivers

3. A body of water shallow enough to allow plant roots to reach the bottom is called a/an _____.
   A pond
   B lake
   C river
   D ocean

4. A pond and a lake are ***different*** because _____.
   A a pond is bigger and more shallow
   B a pond is smaller and deeper
   C a lake is larger and deeper
   D a lake is smaller and deeper

5. Which of the following ecosystems would be ***least likely*** to exist in North Carolina?
   A grassland
   B forest
   C salt marsh
   D lake

6. Why are desert plants ***different*** than most other plants?
   A They receive less water and must compensate for the reduction in water.
   B They receive too much water.
   C Too many animals try to eat these plants.
   D They grow too fast.

7. Every single organism requires the _____ for survival.
   A wind
   B clouds
   C sun
   D land

8. Organisms that make their own energy are called _____.
   A producers
   B consumers
   C filter feeders
   D omnivores

9. Some biotic factors of a community would include _____.
   A trees
   B rabbits
   C owls
   D all of the above

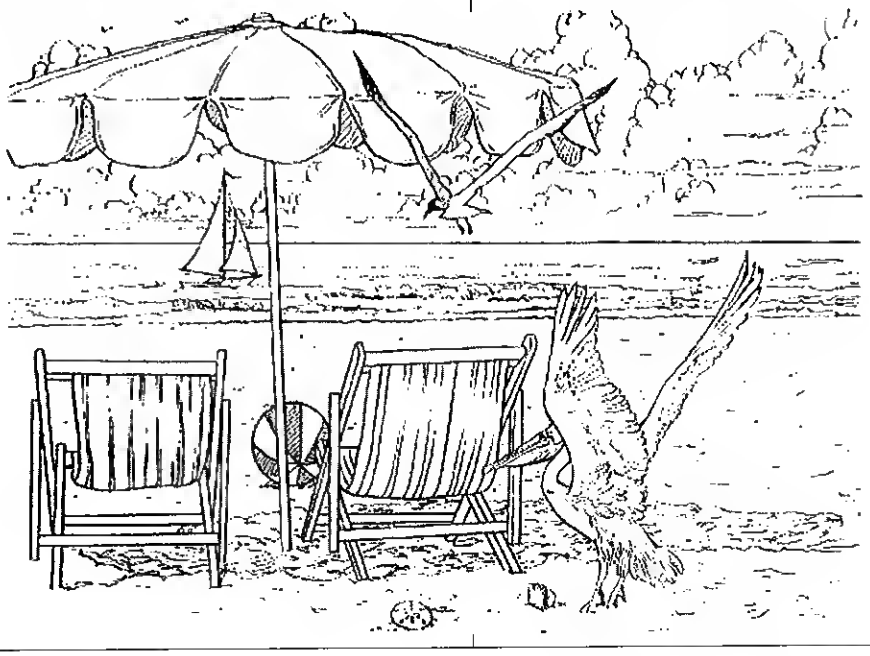
10. All of the following are factors that affect the producers in a community ***except*** _____.
    A type of soil present
    B sunlight
    C water availability
    D presence of worms

11. A group of organisms that represents the primary consumers is _____.
    A perch, frog, tadpole
    B insect, crustacean, tadpole
    C plant, perch, tadpole
    D perch, water beetle, frog

12. The group of organisms that represents the producers is _____.
    A perch, frog, tadpole
    B insect, crustacean, tadpole
    C plant, perch, tadpole
    D none of the above

13. Which animal is an omnivore?
    A a lion that eats deer and sheep
    B a rabbit that eats grass and weeds
    C a bear that eats berries and fish
    D a shark that eats fish and seals

14. Study this picture. An abiotic element of this environment is the _____.
    A seagull
    B pelican
    C water
    D sand dollar



15. This ecosystem in #14 would ***best*** be described as a/an_____.
    A desert
    B ocean
    C tundra
    D grassland

16. The animal that belongs in this chart is a ____.

Habitat	
Animals	**Plants**
Gecko	Cactus
Jack Rabbit	Joshua Tree
Cactus Wren	Tumbleweed

    A prairie dog
    B penguin
    C ringtail monkey
    D whale

17. The element missing in this food chain is_____.

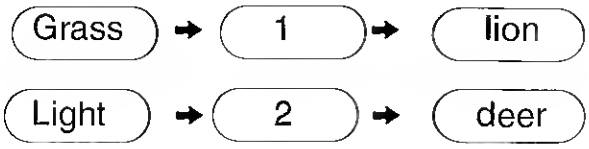
____ ➔ grasshopper ➔ snake ➔ hawk

    A mushroom
    B prairie grass
    C spider
    D mouse

18. An organism which feeds only on producers is _____.
    A a carnivore
    B an herbivore
    C an omnivore
    D a monster

19. Which of the following populations would be found in the tundra?
    A kangaroos, rats, jackrabbits
    B bears, deer, birds
    C foxes, lizards, snakes
    D reindeer, caribou, arctic foxes

Look at the food web below. The arrows point from the energy providers to the energy users.



20. Which of the following ***might*** belong in Circle 2?
    A shrub
    B light
    C water
    D zebra

21. Which of the following ***might*** belong in Circle 1?
    A shrub
    B light
    C water
    D zebra

22. Which biome is characterized by moderate temperatures, moderate rainfall amounts, trees that drop their leaves in winter, and the presence of deer?
    A taiga
    B grassland
    C deciduous forest
    D tundra

23. In an ecosystem, vultures would be classified as _____.
    A producers
    B consumers
    C scavengers
    D decomposers

24. Which of the following factors would ***increase*** the likelihood of a species becoming established in an area?
    A the ability to find food
    B the ability to reproduce
    C the ability to survive fights
    D all of these

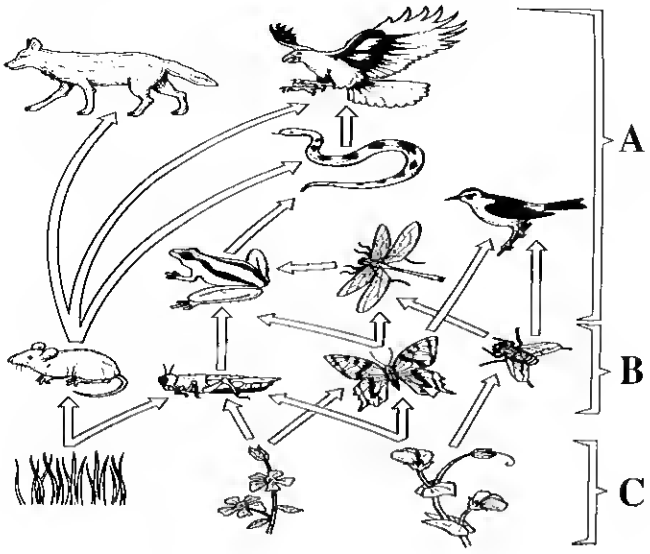
25. A hawk carries a field mouse to its nest to feed its young. The hawk is _____.
    A a herbivore
    B a carnivore
    C an omnivore
    D none of these

26. Which of the following is characteristic of producers?
    A ability to decompose dead organisms
    B ability to undergo photosynthesis
    C ability to hunt
    D ability to eat plants

27. The interrelated chain of organisms that depends on each other for food is called _____.
    A the biome
    B an ecological succession
    C a food web
    D a niche

28. Which of these makes up the abiotic factors in an ecosystem?
    A bacteria, fungi, mosses
    B trees, flowers, grasses
    C mice, raccoons, vultures
    D rocks, minerals, rainfall

29. Use the graphic that follows to answer this question. Which of the following letters represent producers in the food web?



    A A
    B B
    C C
    D B and C

30. Which term refers to the behavior of two species attempting to use the same living space, food source, and water source?
    A saprophytic
    B competitive
    C predatory
    D symbiotic

31. Which group of organisms is an example of a population?
    A leopard frogs in a stream
    B birds in Colorado
    C reptiles in the Sahara Desert
    D trees in a forest

32. Describe the relationship between species and population.

33. Explain how frogs and tadpoles would have different niches.

34. Describe the relationship between producers, primary, secondary, and tertiary consumers, scavengers, and decomposers in an ecosystem.

35. Give a new example of each:

producer _____

primary consumer _____

secondary consumer _____

tertiary consumer _____

scavenger _____

decomposer _____

PRACTICE TEST I

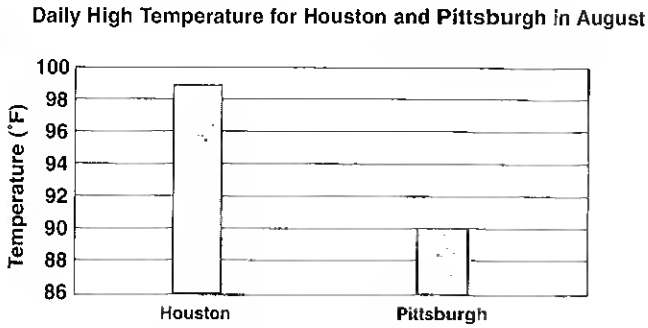
Use the answer sheet provided on page 253.

1. A scientist wants to know how tall a plant will grow using a new fertilizer. What tool would the scientist use to measure growth?
   A ruler
   B thermometer
   C graduated cylinder
   D stopwatch

2. What causes the surface temperature of the Pacific Ocean to rise causing changes in air movement and air temperature, resulting in severe storms in some areas and droughts in other areas?
   A Gulf Stream
   B jet stream
   C tide
   D El Niño

3. What is the temperature according to the thermometer below?
   A 18°C
   B 18°F
   C 20°C
   D 22°C

4. Study the graph below. Based on the data, what conclusion can you draw from the graph?



   A Houston is hotter than Pittsburgh in August.
   B Pittsburgh is hotter than Houston in August.
   C It is more humid in Houston than Pittsburgh in August.
   D It is more humid in Pittsburgh than Houston in August.

5. Which of the following activities fits the scientific definition of work?
   A reading a book
   B feeding the dog
   C pushing a lawnmower
   D taking out the trash

6. Devin wants to test which type of cup, Styrofoam, paper, or plastic, keeps drinks cold longer. After stating the question to be answered, what should the next step be in Devin's experiment?
   A He should design the experiment.
   B He should form a hypothesis.
   C He should identify variables.
   D He should collect the data.

7. Which variable will change in Devin's experiment?
   A the type of cup used
   B the kind of drink used
   C A & B
   D none of the above

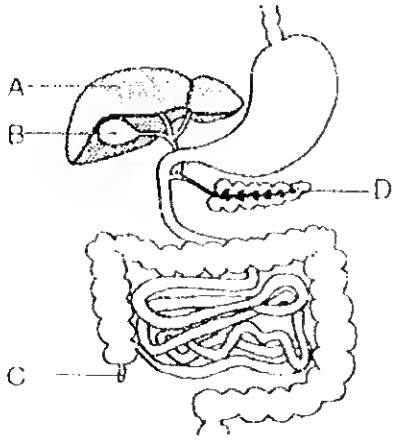
8. A group of like organisms living in the same place at the same time is called a _____.
   A population
   B community
   C neighborhood
   D gang

9. Which of the following takes place in the stomach?
   A bile production
   B insulin production
   C acid production
   D hormone production

10. Which body system delivers nutrients to the cells throughout the body?
    A circulatory system
    B endocrine system
    C respiratory system
    D digestive system

11. As urine is excreted, muscle contractions of the urinary bladder will cause the urine to pass into the _____.
    A ureter
    B urethra
    C kidney
    D large intestine

Use the following diagram to answer questions 12 and 13.



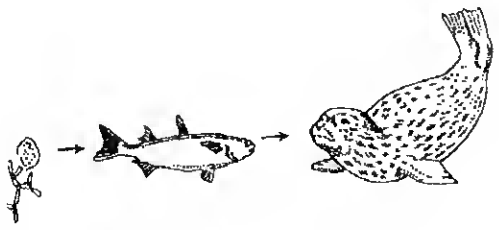
12. Which lettered structure in the diagram produces insulin to remove glucose from the blood?
    A A
    B B
    C C
    D D

13. Which of the following organs in the above diagram stores bile?
    A A
    B B
    C C
    D D

14. The force that is ***most responsible*** for leaves falling from trees is _____.
    A seasonal
    B convection
    C gravity
    D friction

15. The task that would encounter the ***least*** amount of friction is _____.
    A pushing a 20 lb box across a gravel road
    B pulling a 20 lb box across carpet
    C pushing a 20 lb box across a tile floor
    D pulling a 20 lb box across a wooden deck

16. The ecosystem where you would ***most likely*** find this food chain is the _____.



    A forest
    B ocean
    C desert
    D tundra

17. This prairie dog makes its home underground to protect itself from the harsh heat during the day. You would ***most likely*** find him in the _____.

A forest
B desert
C estuary
D pond

18. The biotic elements of this ecosystem are _____.

A beaver, tree, grass
B beaver, leaves, dirt
C trees, air, dirt
D dirt, beaver, tree

19. Joey throws a basketball straight up in the air. If the black arrow represents the force of the throw, then the white arrow represents _____.

A inertia
B convection
C gravity
D friction

20. Water is removed from waste material in what part of the digestive system?
A esophagus
B stomach
C gall bladder
D large intestine

21. The skin functions as an excretory organ because water and wastes leave sweat glands through openings called _____.
A cilia
B pores
C mucus
D flagella

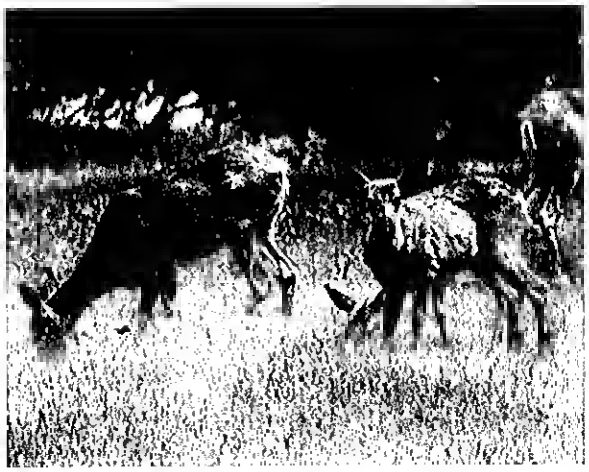
22. Which of the following structures is ***not*** part of the nervous system?
A the brain
B neurons
C spinal cord
D thyroid gland

23. Tara recorded this data to show how far her pet turtle traveled over an 8-hour period of time. Based on this information, how far did the turtle travel after 6 hours?

Time (h)	Distance (m)
2	45
4	90
6	?
8	180

A 105 m
B 125 m
C 135 m
D 150 m

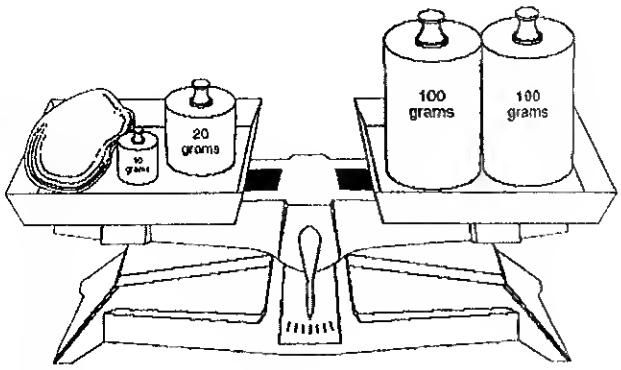
24. These deer feed on the lush grass and shrubs in the forest. They are _____.



A carnivores
B herbivores
C omnivores
D starving

25. Which of the following endocrine glands is ***most*** responsible for the way our bodies react to a stressful situation?
A ovaries
B adrenal glands
C thyroid gland
D pituitary gland

26. The mass of this rock is _____.



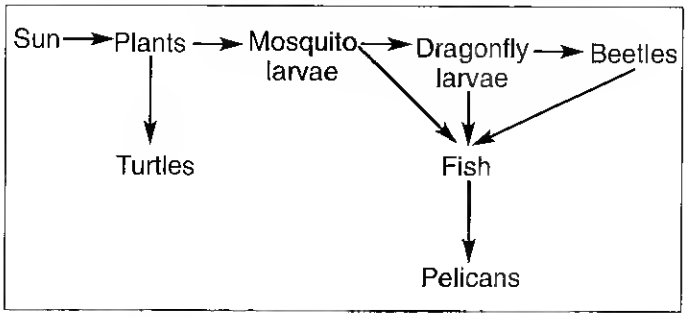
A 30 g
B 200 g
C 170 g
D 150 g

27. This picture shows plants and animals living together in a defined area. This is an example of a _____.

A population
B community
C niche
D town

28. The ecosystem pictured in question #27 is _____.
A a grassland
B tundra
C a desert
D a pond

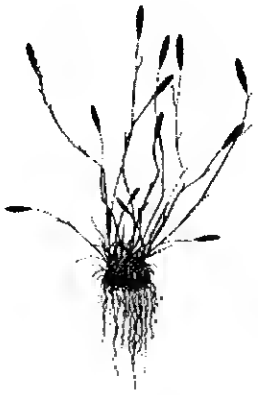
29. The producers in this food web are the _____.



A plants
B turtles
C fish
D mosquito larvae

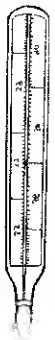
30. A truck will skid more on a wet road than on a dry road. The reason for this is _____.
A there is more friction between the tires and the wet road
B there is more friction between the tires and the dry road
C there is the same amount of friction on the wet and dry road
D friction is not a factor in whether or not the truck will skid

31. This plant was found growing in a body of water. The body of water is shallow enough for the roots to grow on the bottom. This plant ***most likely*** grows in _____.

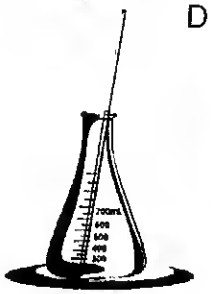


A the ocean
B a lake
C a pond
D the desert

32. The ***best*** tool to determine the time it takes a ball to roll downhill is _____.

A 

B 

C 

D 

33. Most people eat plants and animals. This is an example of a/an _____.
A carnivore
B herbivore
C omnivore
D producer

34. Which of the following will cause a change in motion?
A a balanced force
B an unbalanced force
C inertia
D gravity

35. Which of the following is the ***best*** definition for absorption?
A It is the act of chewing and swallowing food.
B It is the passage of material out of the digestive system.
C It is the chemical breakdown of food in the digestive system.
D It is the transport of nutrient molecules into the cells lining the digestive tract.

36. One role of the skeletal system and the muscular system functioning together is to provide _____.
    A movement
    B protection
    C circulation
    D nutrition

37. Which of the following examples is a physical change in a maple tree?
    A decomposition of bark by bracket fungi
    B starches and sugars being broken down during energy production
    C water and carbon dioxide being converted to glucose
    D evaporation of water from the surface of leaves

38. Where is the greatest amount of sunlight received year-round?
    A at the equator
    B at the poles
    C equally over the Earth
    D at about 30° latitude

39. The movement of air of varying densities is called convection. Cooler air is denser than warmer air. Therefore, convection occurs because _____.
    A warm air pushes up cool air
    B cool air pushes up warm air
    C hot air pushes up warm air
    D water vapor causes air to move

40. A cloud that hangs near ground level is commonly referred to as _____.
    A water vapor
    B dew
    C fog
    D frost

41. The temperature at which condensation forms is called _____.
    A relative humidity
    B dew point
    C evaporation
    D precipitation

42. Fair weather is associated with which of the following areas?
    A low pressure
    B high pressure
    C zero pressure
    D changing pressure

43. In the troposphere, temperatures decrease with increasing altitude. Which of the following places would therefore have the hottest temperature?
    A Death Valley, California
    B Siberia, Russia
    C Mt. Everest
    D the South Pole

44. Bacteria of decay are important to the ecosystem because they _____.
    A recycle organic matter
    B are an important part of photosynthesis
    C absorb solar energy
    D slow the spread of disease

45. Which of the following types of clouds occurs highest in the atmosphere? They appear as wispy curls or feathers.

    A cirrus
    B stratus
    C cumulus
    D nimbus

46. A bird lives in a tree in a forest, where it builds a nest and lays two eggs. The chicks hatch, and the mother feeds the chicks insects she has plucked from the

tree bark. This information helps in determining the bird's _____.
A niche
B rate of metabolism
C biomass
D migratory pattern

47. In a typical terrestrial ecosystem, the primary producers are usually _____.
A abiotic
B animals
C herbivores
D plants

48. Ecosystems are made up of both abiotic and biotic factors. Which of the following is an abiotic part of the ecosystem?
A water
B algae
C yeast
D animals

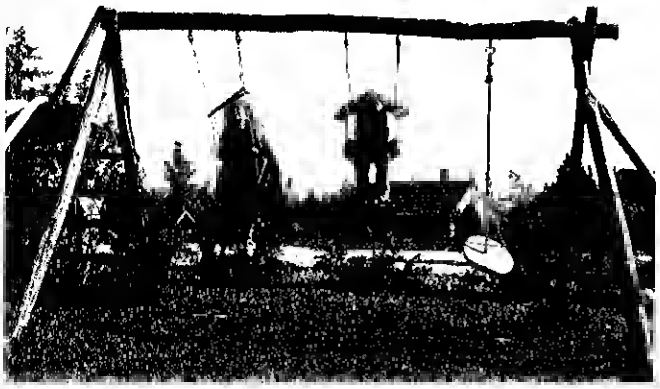
49. Which of the following describes a biome?
A areas of like climate and ecology
B all of the living organisms in an ecosystem
C relationships of living things to each other and their surroundings
D none of the above

50. Anna and Jason had identical bowls of soup, both at the same temperature. Anna put a cover on her bowl. This prevents heat loss through _____.
A convection
B conduction
C radiation
D drying out the soup

51. The origin of all of the energy found in ***most*** ecosystems is _____.
A the sun
B the food pyramid
C the top predator
D the producers

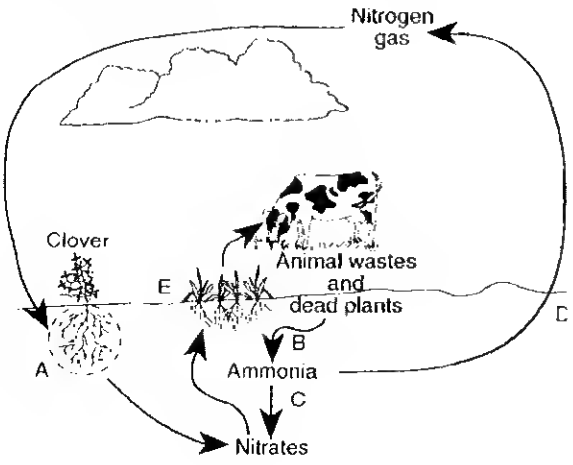
52. Replacing nitrogen in the soil is done by _____.
A secondary consumers
B primary composers
C producers
D decomposers

53. These girls are playing outside on a swing. What is the relationship between the girl doing the pushing and the girl on the swing?



A The lighter the push, the higher the girl on the swing goes.
B The stronger the push, the higher the girl on the swing goes.
C The force of the push does not affect the height of the swinger.
D The height of the swinger will stay the same no matter how hard she is pushed.

Use the following diagram to answer questions 54–55.



54. Letter B represents _____.
    A scavengers
    B decomposers
    C producers
    D omnivores

55. Nitrogen-fixing bacteria are represented by letter _____.
    A A
    B C
    C D
    D E

56. Which of the following is a mixture?
    A kool-aid
    B distilled water
    C sugar
    D potato

57. Which animal is like a human in that its heart contains four chambers?
    A insect
    B amphibian
    C bird
    D mollusk

58. A land area that is characterized by grasses, lichens, caribou, and polar bears is called _____.
    A a grassland
    B a tundra
    C a taiga
    D a temperate forest

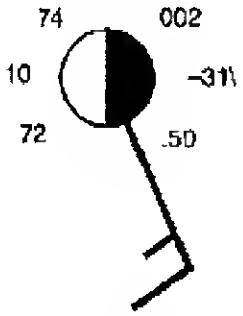
59. Two cars travel the same route from Charlotte to Wilmington. Car A has an average speed of 55 mph while Car B has an average speed of 45 mph. Which car will reach Wilmington last?
    A Car A
    B Car B
    C They will reach Wilmington at the same time.
    D neither will reach Wilmington

60. A candy bar left in a hot car will change states of matter from_____.
    A a liquid to a gas
    B a solid to a gas
    C a solid to a liquid
    D a liquid to a solid

61. What type of front and frontal movement is shown on this map?

    A cold front moving northwest
    B cold front moving southeast
    C warm front moving northwest
    D warm front moving southeast

62. Which statement is true concerning this weather symbol?



    A The temperature is 74°F and the pressure is 1000.2 mb.
    B The temperature is 72°F and the pressure is 1002 mb.
    C The temperature is 74°F and the dew point is 002°F.
    D The temperature is 72°F and it is a clear sky.

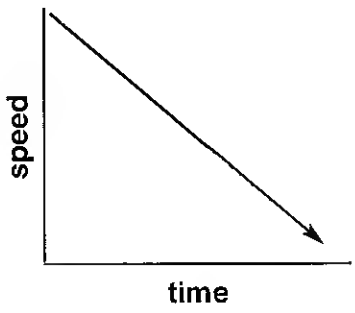
63. Margaret made a fruit salad using grapes, blueberries, and raspberries. Which statement is ***most likely*** true?
    A The weight of the fruit salad is greater than the weights of the three fruits together.
    B The weight of the fruit salad is less than the weights of the three fruits together.
    C The weight of the fruit salad is equal to the weights of the three fruits together.
    D Fruit salad cannot be weighed correctly.

64. Which of the following describes a change in which one or more new types of matter form?
    A physical change
    B change of state
    C transfer of heat
    D chemical change

Use the formula speed = distance/time to answer the following question.

65. About how many minutes will it take a car to reach its destination if it has to travel 50 miles at 70 miles per hour?
    A 70 minutes
    B 26 minutes
    C 43 minutes
    D 58 minutes

66. Which statement ***best*** summarizes the information in the following graph?



    A Speed and time are at the same rate.
    B Speed will always decrease.
    C As time decreases, speed increases.
    D As time increases, speed decreases.

67. How is a conductor different from an insulator?
    A Heat moves through an insulator more easily than through a conductor.
    B Heat moves through a conductor more easily than through an insulator.
    C A conductor is more flexible than an insulator.
    D An insulator is more flexible than a conductor.

68. Why does the equator stay warm year-round while the North and South Poles are cold year-round?
    A The equator is located south of the South Pole.
    B The equator is located north of the North Pole.
    C The equator receives more direct sunlight than the North or South Pole.
    D The equator contains competing air masses.

69. After a large thunderstorm, there are puddles of water on the concrete driveway. After a few hours, the puddles have disappeared. What process has occurred?
    A condensation
    B evaporation
    C dew point
    D transpiration

70. You throw a ball straight up into the air. What force acts upon the ball as soon as it is released?
    A the upward force of the hand
    B the upward force of gravity
    C the downward force of the hand
    D the downward force of gravity

71. Losing speed as you ride uphill demonstrates Newton's _____ Law of Motion.
    A First
    B Second
    C Third
    D Fourth

72. A chemical change takes place when _____.
    A a pear is diced
    B ice cream melts
    C coffee boils
    D a banana rots

73. Which of the following is a physical change?
    A burning paper
    B cutting a piece of paper into strips
    C iron rusting
    D glow stick lighting up

74. Which of the following is a good conductor of heat?
    A stainless steel
    B glass
    C rubber
    D wood

75. What would ***most likely*** happen when you put a cold liquid into a hot cup?
    A The cup will become cooler.
    B The cup will become hotter.
    C The liquid will become cooler.
    D The liquid will stay the same.

76. If you heard a weather report that said the barometer was falling, what might be happening?
    A A storm would be approaching.
    B There would be clear skies.
    C Some wispy clouds would be in the sky.
    D Cold, clear weather is approaching.

77. When a cold glass of iced tea is left on a table, water drops form on it. Where did the drops come from?
    A the tea
    B the ice
    C the air
    D the glass

78. Which example below uses the common definition of work?
    A throwing a ball
    B reading a book
    C lifting a box
    D pushing a lawnmower

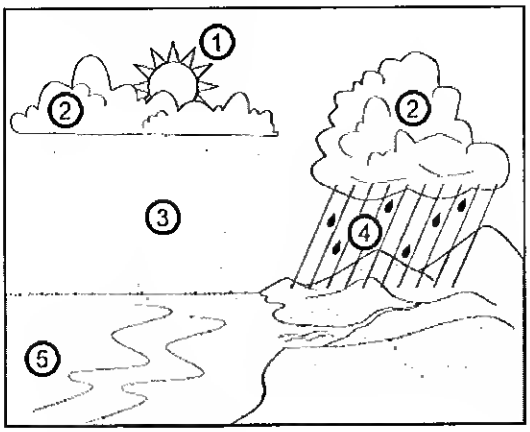
79. Latitudes that are farthest from the equator usually _____.
    A have tornadoes
    B get a lot of rain
    C are cold all year
    D are hot all year

80. Which of the following ***best*** describes an object's velocity?
    A A car travels at 25 mph for 2 hours.
    B An airplane travels southwest at 280 mph.
    C A bus went from 30 mph to 40 mph.
    D A bicycle made several stops with an average of 5 mph.

81. A coin and feather are dropped at the same distance from the ground. The coin drops faster because it has less _____ than the feather.
    A inertia
    B buoyancy
    C speed
    D air resistance

82. Clouds are found only in the _____.
    A stratosphere
    B troposphere
    C lithosphere
    D hydrosphere

83. What step of the water cycle is illustrated by #4?



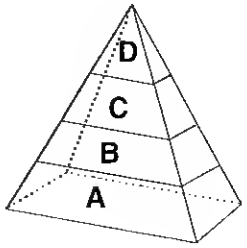
A transpiration
B condensation
C evaporation
D precipitation

84. After sunset, mountain slopes cool rapidly. Cool air rushes rapidly down into the valley creating a/an _____.
A ocean current
B Gulf Stream
C mountain breeze
D valley breeze

85. The _____ is a fast moving narrow zone of air in the troposphere first found by pilots when they were flying their airplanes.
A atmosphere
B troposphere
C Gulf Stream
D jet stream

86. The following diagram represents a biomass pyramid. Which level of the pyramid ***most likely*** contains the greatest mass of herbivores?

A A
B B
C C
D D



87. The mouth, pharynx, esophagus, stomach, small intestine, and large intestine all help to break down food particles so that the cells can use them. This process is called _____.
A secretion
B excretion
C digestion
D circulation

88. Michelle drove 700 km in 10 hours. What was her average speed? (speed = distance/time)
A 7,000 km/hr
B 70 km/hr
C 0.7 km/hr
D 700 km/hr

89. Which group of organisms is an example of a population?
A leopard frogs in a stream
B birds in Colorado
C reptiles in the Sahara Desert
D trees in a forest

90. Which Law of Motion states that when an unbalanced force is applied to an object, the object accelerates?
A First
B First and Second
C Second
D Third

91. Which surface would provide ***less*** friction when rolling a cart across it?
A a tile floor
B grass
C a carpeted floor
D mud

92. Which of the following does ***not*** affect the speed with which objects fall or move downhill?
A smoothness of surface
B roughness of surface
C height of ramp
D weight or mass

PRACTICE TEST 1 BREAKDOWN

Chapters	Related Problems
1—Scientific Inquiry	1, 3, 4, 6, 7, 23, 26
2—Understanding Force and Motion	5, 14, 15, 19, 30, 32, 34, 53, 59, 65, 66, 70, 71, 78, 80, 88, 90, 91, 92
3—Matter and Energy	37, 50, 60, 63, 64, 67, 72, 73, 74, 75, 81, 83
4—Understanding Weather and Climate	2, 38, 39, 40, 41, 42, 43, 45, 61, 62, 68, 69, 76, 77, 79, 82, 84, 85
5—Living Organisms	9, 10, 11, 12, 13, 20, 21, 22, 25, 35, 36, 87
6—Populations and Ecosystems	8, 16, 17, 18, 24, 27, 28, 29, 31, 33, 44, 46, 47, 48, 49, 51, 52, 54, 55, 56, 57, 58, 86, 89

ANSWER SHEET
EOG 5th Grade SCIENCE — PRACTICE TEST 1

Name_____

INSTRUCTIONS:

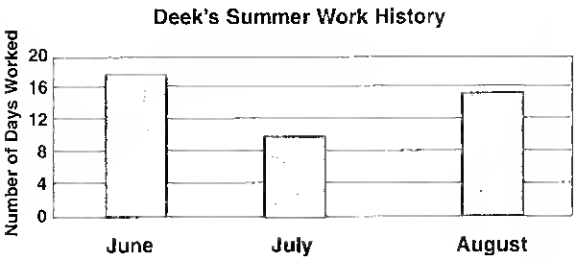
1. Fill in your name at the top of this page.
2. Tear out this page.
3. Answer each question and fill in the appropriate bubbles (A, B, C, or D) on this sheet.
4. Once your teacher grades your answers, circle the numbers of your missed questions on the "Practice Test 1 Breakdown" sheet.
5. By looking at the circled numbers on the breakdown sheet, you will be able to tell which areas (chapters) you need to study.

1. Ⓐ Ⓑ Ⓒ Ⓓ	24. Ⓐ Ⓑ Ⓒ Ⓓ	47. Ⓐ Ⓑ Ⓒ Ⓓ	70. Ⓐ Ⓑ Ⓒ Ⓓ
2. Ⓐ Ⓑ Ⓒ Ⓓ	25. Ⓐ Ⓑ Ⓒ Ⓓ	48. Ⓐ Ⓑ Ⓒ Ⓓ	71. Ⓐ Ⓑ Ⓒ Ⓓ
3. Ⓐ Ⓑ Ⓒ Ⓓ	26. Ⓐ Ⓑ Ⓒ Ⓓ	49. Ⓐ Ⓑ Ⓒ Ⓓ	72. Ⓐ Ⓑ Ⓒ Ⓓ
4. Ⓐ Ⓑ Ⓒ Ⓓ	27. Ⓐ Ⓑ Ⓒ Ⓓ	50. Ⓐ Ⓑ Ⓒ Ⓓ	73. Ⓐ Ⓑ Ⓒ Ⓓ
5. Ⓐ Ⓑ Ⓒ Ⓓ	28. Ⓐ Ⓑ Ⓒ Ⓓ	51. Ⓐ Ⓑ Ⓒ Ⓓ	74. Ⓐ Ⓑ Ⓒ Ⓓ
6. Ⓐ Ⓑ Ⓒ Ⓓ	29. Ⓐ Ⓑ Ⓒ Ⓓ	52. Ⓐ Ⓑ Ⓒ Ⓓ	75. Ⓐ Ⓑ Ⓒ Ⓓ
7. Ⓐ Ⓑ Ⓒ Ⓓ	30. Ⓐ Ⓑ Ⓒ Ⓓ	53. Ⓐ Ⓑ Ⓒ Ⓓ	76. Ⓐ Ⓑ Ⓒ Ⓓ
8. Ⓐ Ⓑ Ⓒ Ⓓ	31. Ⓐ Ⓑ Ⓒ Ⓓ	54. Ⓐ Ⓑ Ⓒ Ⓓ	77. Ⓐ Ⓑ Ⓒ Ⓓ
9. Ⓐ Ⓑ Ⓒ Ⓓ	32. Ⓐ Ⓑ Ⓒ Ⓓ	55. Ⓐ Ⓑ Ⓒ Ⓓ	78. Ⓐ Ⓑ Ⓒ Ⓓ
10. Ⓐ Ⓑ Ⓒ Ⓓ	33. Ⓐ Ⓑ Ⓒ Ⓓ	56. Ⓐ Ⓑ Ⓒ Ⓓ	79. Ⓐ Ⓑ Ⓒ Ⓓ
11. Ⓐ Ⓑ Ⓒ Ⓓ	34. Ⓐ Ⓑ Ⓒ Ⓓ	57. Ⓐ Ⓑ Ⓒ Ⓓ	80. Ⓐ Ⓑ Ⓒ Ⓓ
12. Ⓐ Ⓑ Ⓒ Ⓓ	35. Ⓐ Ⓑ Ⓒ Ⓓ	58. Ⓐ Ⓑ Ⓒ Ⓓ	81. Ⓐ Ⓑ Ⓒ Ⓓ
13. Ⓐ Ⓑ Ⓒ Ⓓ	36. Ⓐ Ⓑ Ⓒ Ⓓ	59. Ⓐ Ⓑ Ⓒ Ⓓ	82. Ⓐ Ⓑ Ⓒ Ⓓ
14. Ⓐ Ⓑ Ⓒ Ⓓ	37. Ⓐ Ⓑ Ⓒ Ⓓ	60. Ⓐ Ⓑ Ⓒ Ⓓ	83. Ⓐ Ⓑ Ⓒ Ⓓ
15. Ⓐ Ⓑ Ⓒ Ⓓ	38. Ⓐ Ⓑ Ⓒ Ⓓ	61. Ⓐ Ⓑ Ⓒ Ⓓ	84. Ⓐ Ⓑ Ⓒ Ⓓ
16. Ⓐ Ⓑ Ⓒ Ⓓ	39. Ⓐ Ⓑ Ⓒ Ⓓ	62. Ⓐ Ⓑ Ⓒ Ⓓ	85. Ⓐ Ⓑ Ⓒ Ⓓ
17. Ⓐ Ⓑ Ⓒ Ⓓ	40. Ⓐ Ⓑ Ⓒ Ⓓ	63. Ⓐ Ⓑ Ⓒ Ⓓ	86. Ⓐ Ⓑ Ⓒ Ⓓ
18. Ⓐ Ⓑ Ⓒ Ⓓ	41. Ⓐ Ⓑ Ⓒ Ⓓ	64. Ⓐ Ⓑ Ⓒ Ⓓ	87. Ⓐ Ⓑ Ⓒ Ⓓ
19. Ⓐ Ⓑ Ⓒ Ⓓ	42. Ⓐ Ⓑ Ⓒ Ⓓ	65. Ⓐ Ⓑ Ⓒ Ⓓ	88. Ⓐ Ⓑ Ⓒ Ⓓ
20. Ⓐ Ⓑ Ⓒ Ⓓ	43. Ⓐ Ⓑ Ⓒ Ⓓ	66. Ⓐ Ⓑ Ⓒ Ⓓ	89. Ⓐ Ⓑ Ⓒ Ⓓ
21. Ⓐ Ⓑ Ⓒ Ⓓ	44. Ⓐ Ⓑ Ⓒ Ⓓ	67. Ⓐ Ⓑ Ⓒ Ⓓ	90. Ⓐ Ⓑ Ⓒ Ⓓ
22. Ⓐ Ⓑ Ⓒ Ⓓ	45. Ⓐ Ⓑ Ⓒ Ⓓ	68. Ⓐ Ⓑ Ⓒ Ⓓ	91. Ⓐ Ⓑ Ⓒ Ⓓ
23. Ⓐ Ⓑ Ⓒ Ⓓ	46. Ⓐ Ⓑ Ⓒ Ⓓ	69. Ⓐ Ⓑ Ⓒ Ⓓ	92. Ⓐ Ⓑ Ⓒ Ⓓ

PRACTICE TEST 2

Use the answer sheet provided on page 267.

1. Deek works at his father's store in the summertime only when they are very busy. Using the graph below, infer which month his father's store was the busiest.



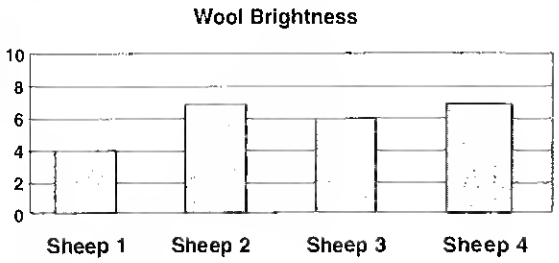
A June
B July
C August
D You cannot tell from the data which month was the busiest.

2. You have been asked to judge a sheep contest at the State Fair. The body length of each animal is used to judge approximately how much wool the sheep might produce. In general, the longer the body the greater the wool production. Based on the data in the table below, predict which animal will produce the most wool.

Sheep	Body Length
1	50 cm
2	51 cm
3	49 cm
4	53 cm

A 1
B 2
C 3
D 4

3. Good wool should be bright white close to the animal's skin. A color scale of 1 (dullest) –10 (brightest) is used to compare the wool color of the contestants. The results are recorded in the graph below. Infer which animal has the whitest wool.

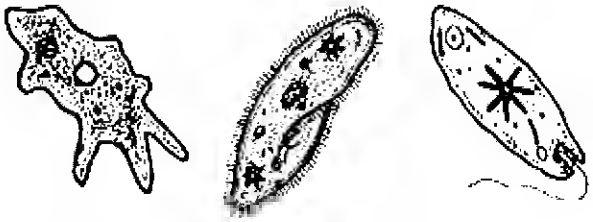


A 1
B 2
C 3
D 2 & 4

4. Based on the combination of body length and wool color, predict which animal will take home the blue ribbon using the graphs in # 2 and #3.
A 2
B 3
C 4
D You cannot tell from the data which animal will take home the blue ribbon.

5. When cells undergo metabolic activities, many organisms produce harmful substances. These substances are eliminated by a process of _____.
A ingestion
B secretion
C reproduction
D excretion

6. Which structures are involved in locomotion in the pictures below?



A cilia only
B cilia and flagella
C cilia and pseudopodia only
D cilia, flagella and pseudopodia

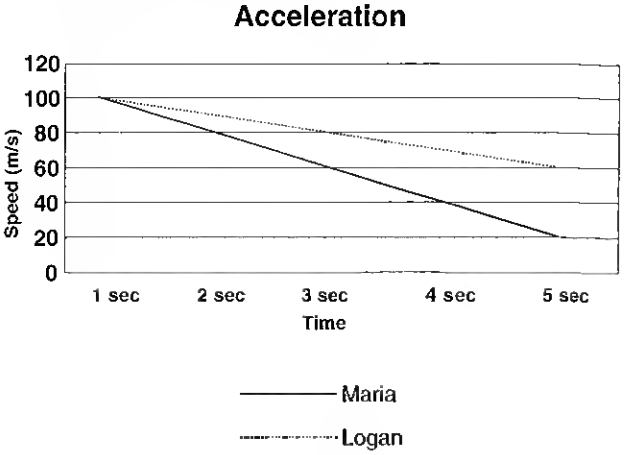
7. Which biological process is the main source of atmospheric oxygen?
A respiration
B digestion
C absorption
D excretion

8. A structure that performs a specialized function within a cell is known as a(n) _____.
A tissue
B organelle
C organ
D system

9. What part of the respiratory system is a thin, moist membrane structure where gas exchange takes place?
A lung
B bronchi
C alveoli
D heart

10. In the human central nervous system, the medulla directly controls _____.
A voluntary activity
B involuntary activity
C memory
D balance

11. What can you conclude from the data below?

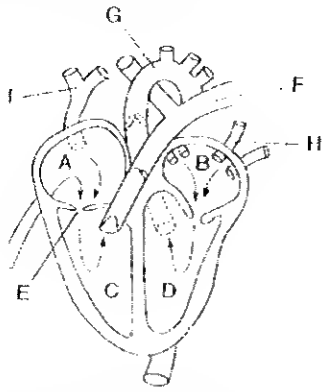


A Logan is accelerating faster than Maria.
B Maria's speed is decreasing faster than Logan's.
C Logan's speed is decreasing faster than Maria's.
D Maria's velocity is greater than Logan's.

12. The human growth hormone allows us to grow at a regular rate during our lives. What endocrine gland, nicknamed the "master gland," produces this hormone?
A the testes
B the pituitary gland
C the pineal gland
D the ovaries

13. Hunter is visiting an ecosystem. There are cattails growing at the edge of the water and fish are swimming near the surface. Hunter is ***most likely*** in _____.
A the forest
B a pond
C the ocean
D the grasslands

Use the diagram of the heart below to answer questions 14-15.



14. Which structures carry oxygenated blood to the body?
    A A, B, H, and I
    B A, C, E and F
    C B, D, G and H
    D B, C, G and F

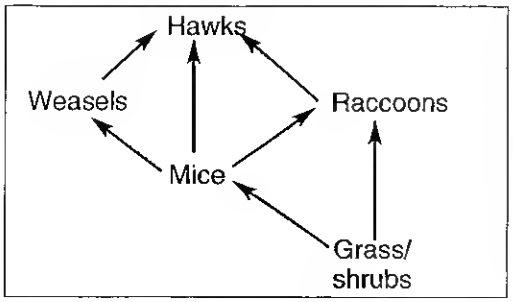
15. Which letter indicates the pulmonary artery?
    A F
    B G
    C H
    D I

16. Grasslands Food Chain

    wheat plant ➔ _____ ➔ snakes ➔ owls

    The missing link in this food chain is _____.
    A a mouse
    B a hawk
    C oat plants
    D bison

17. This food web is ***most likely*** found in which ecosystem?



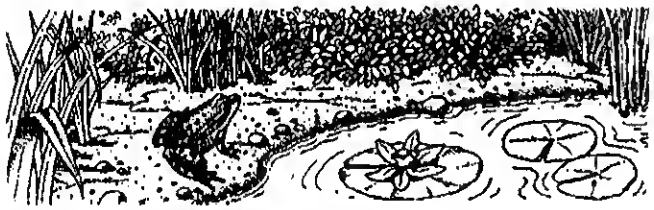
    A tundra
    B desert
    C ocean
    D pond

18. A car traveled 150 km in 3 hours. What was its average speed in km per hour? (speed = distance/time)
    A 153 km/hr
    B 50 km/hr
    C 53 km/hr
    D 100 km/hr

19. In this diagram, aphids are _____.

    plants ➔ aphids ➔ spiders ➔ sparrows
    A producers
    B consumers
    C decomposers
    D parasites

20. The producers in this ecosystem are _____.



    A frogs
    B water
    C sand
    D plants

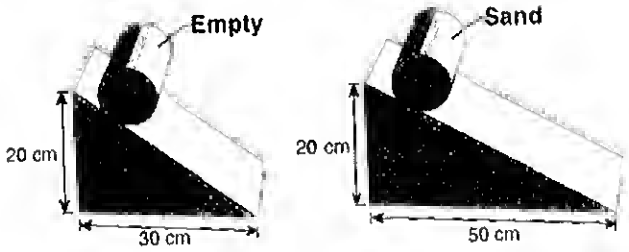
21. Kevin moved a 50 kg box, 15 m. In this diagram 20N is the amount of _____.

    A inertia
    B gravity
    C weight
    D force

22. Which part of the human brain acts as a "thermostat" to control our internal temperature?
    A the medulla
    B the pineal gland
    C the cerebellum
    D the hypothalamus

23. Bacteria of decay are important to the ecosystem because they _____.
    A recycle organic matter
    B are an important part of photosynthesis
    C absorb solar energy
    D slow the spread of disease

24. Erin is trying to conduct a fair test to determine if an empty or full cylinder will reach the bottom of the ramp first. The change Erin needs to make in order for this to be a fair test is _____.



    A make one ramp 30 cm and the other 20 cm
    B fill both cylinders with sand
    C make the height and length of each ramp the same
    D make no change

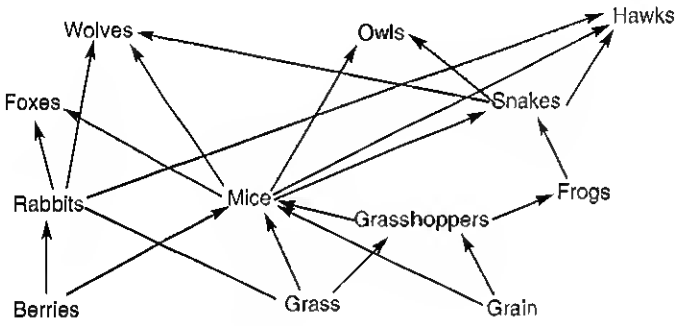
25. All of the Earth's water, land and atmosphere within which life exists is known as the _____.
    A population
    B niche
    C biome
    D biosphere

26. Study the table. The cars that have the same velocity are _____.

Car A Driving 50 km/hr on Hwy 17 north
Car B Driving 80 km/hr on Hwy 9 east
Car C Driving 50 km/hr on Interstate 20 east
Car D Driving 80 km/hr on Interstate 20 east

    A Car A and Car B
    B Car B and Car C
    C Car B and Car D
    D Car C and Car D

27. In this diagram, the owl is a predator of the _____.



    A grasshoppers
    B wolves
    C rabbits
    D mice

28. What causes matter to change states?
    A energy from heat
    B energy from water
    C energy from air
    D energy from your brain

29. You travel with your family 480 km to go on vacation. It takes you 8 hours to get there. Your average speed is _____. (speed = distance/time)
    A 3,840 km/hr
    B 60 km/hr
    C 80 km/hr
    D 50 km/hr

30. When riding your bike on a gravel road, friction will cause you to _____.
    A slow down
    B speed up
    C make no change in your rate of speed
    D stop

31. Which of the following is a property of gas?
    A Gas molecules are packed together in a rigid way.
    B Gas molecules flow.
    C Gas molecules are spread far apart and move quickly.
    D Gas molecules are rigid.

32. Predict what will happen if condensed water sits around long enough.
    A It will boil.
    B It will evaporate.
    C It will turn into ice.
    D It will remain the same.

33. Insulation helps keep homes warm by preventing heat loss through _____.
    A conduction
    B convection
    C radiation
    D magnetism

34. Which of the following is defined as the measure of the pull of gravity on a given mass?
    A matter
    B weight
    C force
    D work

35. Balanced forces are _____ in direction and _____ in size.
    A opposite; equal
    B equal; opposite
    C equal; equal
    D opposite; opposite

36. A tropical climate has precipitation all year long because air near the equator is _____.
    A rising
    B sinking
    C moving sideways
    D not moving

37. The whole Earth has convection cells that are turned by the Coriolis effect. This produces how many basic wind belts?
    A one
    B two
    C three
    D four

38. At greater heights, the same volume of air contains _____ molecules.
    A a greater number of
    B a constant number of
    C a smaller number of
    D more water vapor

39. Water vapor that condenses on surfaces as a solid is called _____.
    A snow
    B frost
    C rain
    D dew

40. The puffy clouds that look like cotton balls are called _____.

    A cumulus
    B stratus
    C cirrus
    D nimbus

41. The leading edge of a moving air mass is called a _____.
    A middle
    B front
    C side
    D back

42. Which of the following weather phenomena is a funnel-shaped cloud that dips down from a violent cumulonimbus cloud? It can be the most destructive of all storms.
    A hurricane
    B tornado
    C thundershower
    D hail

43. A foggy bathroom mirror illustrates which of the following?
    A evaporation
    B condensation
    C precipitation
    D frost

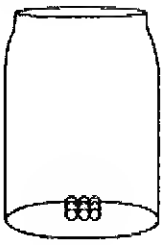
44. Which atmospheric layer is closest to the Earth?
    A stratosphere
    B mesosphere
    C troposphere
    D thermosphere

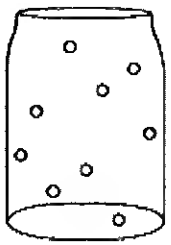
45. Our ears sometimes "pop" when we ride up a steep hill because of _____.
    A changes in air pressure
    B changes in temperature
    C motion sickness
    D bone density changes

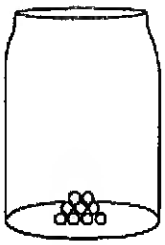
46. Which will tell you the ***most*** about the mass of an object?
    A touching it
    B lifting it
    C looking at it
    D taking it apart

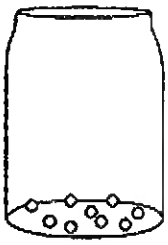
47. Which of the following is defined as a push or pull on matter which can change its direction?
    A gravity
    B mass
    C force
    D weight

48. The diagram that ***best*** represents a gas is _____.

A 

B 

C 

D 

49. On cold mornings, you might rub your hands together _____.
    A to stay awake
    B to produce heat
    C to start a fire
    D to exercise

50. Climate and terrain make up _____.
    A the biotic factors of an environment
    B the abiotic factors of an environment
    C the food web of an ecosystem
    D all of the above

51. The population of a specific species may be affected by _____.
    A changes in the environment
    B a decrease in the available food supply
    C destruction of their habitat
    D all of these

52. Jose is conducting an experiment to determine which object requires more air to blow it off of a table. He placed the objects on the table and blew the same amount of air at each one. Which object ***most likely*** blew off the table with the least amount of force?
    A a napkin
    B a spoon
    C a book
    D a cup

53. Which of the following is an abiotic factor of an ecosystem?
    A the surrounding terrain
    B the local plants
    C the local animals
    D the presence of bacteria

54. If a land community develops into an area containing weeds, the first animals to inhabit the area will be _____.
    A owls
    B grasshoppers
    C foxes
    D people

55. Deer, birds, and many small animals inhabit _____.
    A the tropical rainforest
    B the desert
    C the deciduous forest
    D the taiga

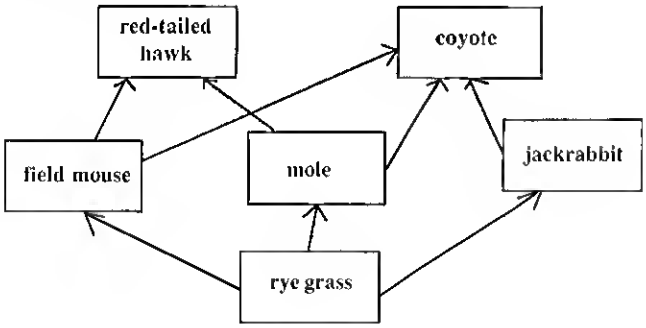
56. Glaciers have begun to melt due to global warming. When glaciers melt, they are undergoing a _____ change.
    A chemical
    B heat energy
    C physical
    D definite

57. Speed can be calculated by dividing distance by time. What is the speed of a tractor which covers 9 miles in 15 minutes?
    A 30 miles/hour
    B 27 miles/hour
    C 36 miles/hour
    D 45 miles/hour

58. Which of the following is the coldest biome?
    A tropical rainforest
    B grasslands
    C taiga
    D tundra

59. Which of the following is the driest biome?
    A deciduous forest
    B desert
    C tundra
    D grasslands

Use the following diagram to answer question #60.



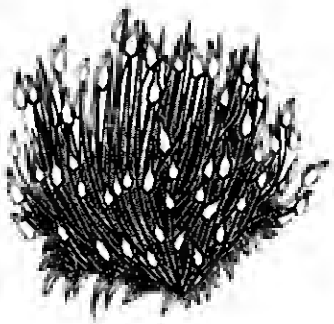
60. Sometimes organisms compete with each other for food. According to the diagram, which of the following organisms compete with each other over a food source?
    A coyotes and moles
    B jackrabbits and red-tailed hawks
    C field mice and jackrabbits
    D field mice and coyotes

61. Which of the following would be classified as a consumer?

A 

B 

C 

D 

62. A niche _____.
   - A includes all aspects of an organism's lifestyle
   - B is unvarying for a given species
   - C is the same as a habitat
   - D refers to location only

63. Two species in the same habitat can coexist when they _____.
   - A differ in their use of resources
   - B share the same resources in different ways
   - C use the same resources at different times
   - D all of the above

64. According to Newton's _____ Law of Motion, an object with no net force acting on it remains at rest or in motion with a constant velocity.
   - A Third
   - B Fourth
   - C First
   - D Second

65. A cyclist finishes a 100 km race in 2.7 hours. The average speed _____.
   - A equals the greatest speed divided by the total time
   - B equals the time divided by the distance
   - C equals the distance divided by the total time
   - D equals force times mass

66. When blocks of "dry ice," which are made of frozen carbon dioxide, warm up, vapors start swirling around them. The vapor forms because the solid carbon dioxide is changing directly into a gas. This process is called _____.

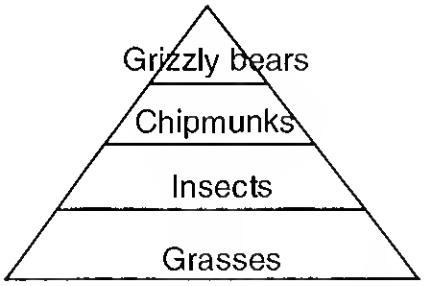
   - A vaporization
   - B sublimation
   - C deposition
   - D condensation

67. Newton's Third Law of Motion states that every force is accompanied by an equal and opposite force. This is ***best*** illustrated by _____.
    A a ball bouncing on the ground
    B sunglasses sliding off a truck's dashboard as the truck turns a sharp corner
    C a motorcycle accelerating as it rolls down the hill
    D an apple falling off a table

68. Which of the following ***best*** describes a material that can be hammered or rolled into sheets?
    A soluble
    B flammable
    C magnetic
    D malleable

69. What gas makes up the largest percentage of the Earth's atmosphere?
    A oxygen
    B nitrogen
    C argon
    D carbon dioxide

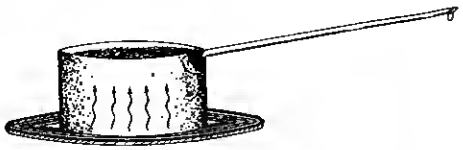
Use the following diagram to answer question #70.



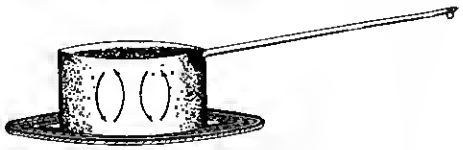
70. In the pyramid above, feeding relationships are shown. Which is the ***best*** statement that describes the information in the pyramid?
    A Chipmunks and insects can occupy the same niche.
    B As the number of bears in this community increases, the number of chipmunks will increase.
    C Insects are classified as omnivores in this community.
    D Biomass decreases as energy is transferred from one level to another.

71. Which of the hot pots illustrates the heat flow of conduction?

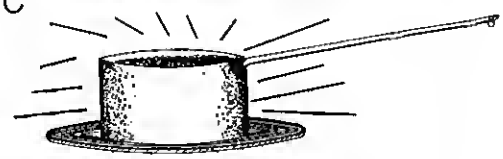
A



B

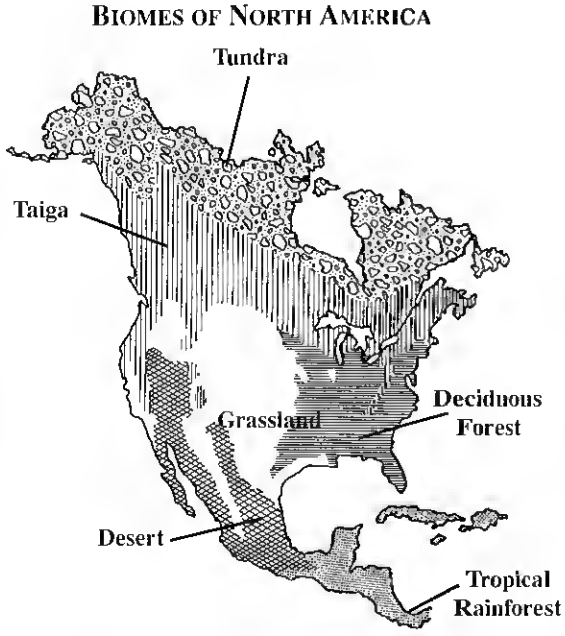


C



72. Both grasslands and forests are _____.
    A tundra
    B desertlike
    C aquatic ecosystems
    D terrestrial ecosystems

Use the following diagram to answer questions 73-75.

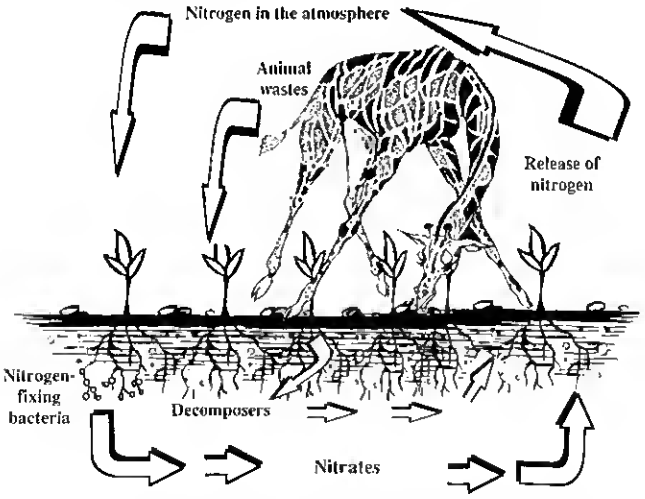


73. Which flora would be a major part of the grassland biome?
    A conifers
    B deciduous trees
    C succulents
    D grasses

74. Which biome indicates an area with coniferous trees, severe winters and black bears and wolves?
    A taiga
    B tundra
    C tropical rainforest
    D desert

75. Which is one characteristic of the tundra biome?
    A permanently frozen subsoil
    B dangerous temperature fluctuations
    C drought resistant shrubs
    D deciduous trees

76. What information is presented in the picture below?



    A Respiration and photosynthesis are related.
    B Transpiration and condensation are related to the water cycle.
    C Decomposers release a material that is acted on by other organisms.
    D Predators and their prey are involved in many interactions.

77. The heat from the sun reaches Earth by_____.
    A conduction
    B convection
    C radiation
    D all of the above

The following nutrition data were collected from two popular snack foods. Use this data to answer questions 78–80.

Nutrition	Snack A	Snack B
Serving Size	44 g	44 g
Calories	160	320
Calories from fat	25	180
Total fat	3 g	22 g
Saturated fat	0.5 g	3 g
Cholesterol	0 mg	0 mg
Sodium	115 mg	340 mg
Protein	2 g	0 g

78. Which snack has more total fat?
    A A
    B B
    C They have the same amount of fat.
    D You cannot tell from the data.

79. Which snack has more cholesterol?
    A A
    B B
    C They have the same amount of cholesterol.
    D You cannot tell from the data.

80. Infer which snack might be potato chips.
    A A
    B B
    C Either snack could be potato chips.
    D You cannot tell from the data.

81. If a car is traveling at an average speed of 60 kilometers per hour, how long does it take to travel 12 kilometers? (speed = distance/time)
    A 0.2 hour
    B 0.5 hour
    C 0.72 hour
    D 5.0 hours

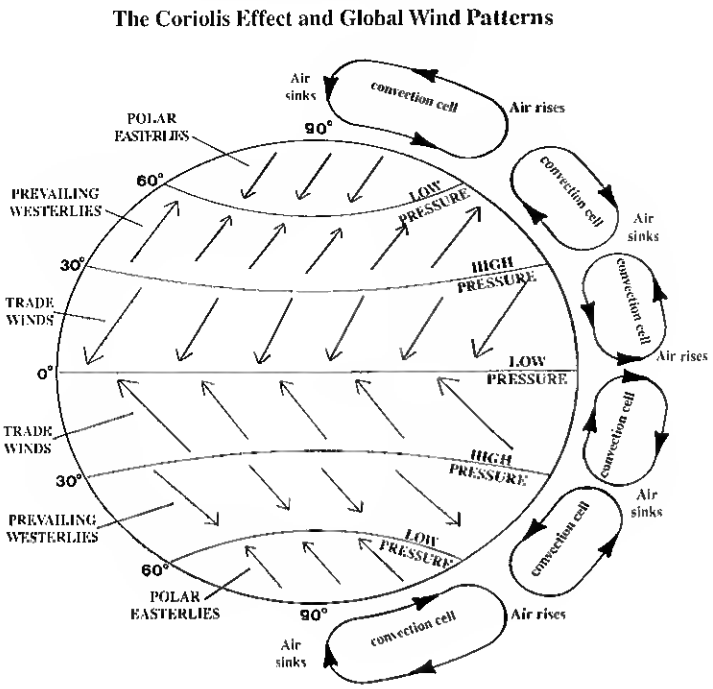
82. Why does a passenger sitting in the front seat of a car hit the windshield when the car comes to a sudden stop if he is not wearing his seatbelt?
    A inertia
    B acceleration
    C gravity
    D displacement

83. A force can _____ if an object is not moving.
    A change its direction
    B make it start moving
    C stop movement
    D slow movement

84. In North Carolina, what form of precipitation falls ***most*** often?
    A snow
    B sleet
    C rain
    D hail

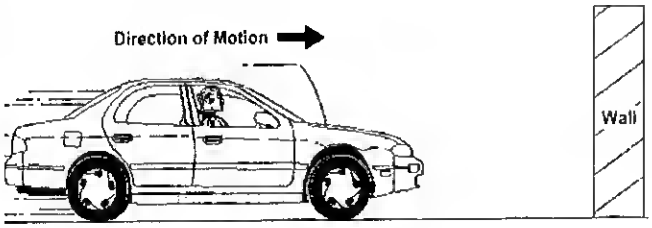
85. If equal but opposite parallel forces act on each other, the end result is _____.
    A objects move up
    B objects move left
    C objects move south
    D objects do not move

86. The surface winds shown in this picture follow curved paths due to the Earth's _____.



    A revolution
    B rotation
    C gravitational field
    D magnetic field

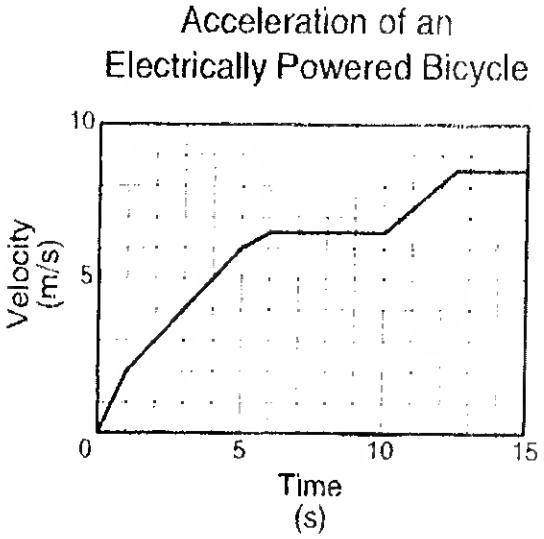
Use the following picture to answer question #87.



87. When the car above accelerates from a standing start, the crash test dummy appears to be pressed backward into the seat cushions. Which of the following ***best*** explains why this happens?
    A The crash test dummy gets lighter as the car accelerates.
    B The car is moving forward faster than the crash test dummy.

C There is no reaction to the force of the car taking off.
D Gravity is pulling the crash test dummy in the direction the car is moving.

Use the following graph to answer question #88.



88. According to the above graph, what was the bicycle's acceleration between 6 seconds and 10 seconds?
A 0 m/s^2
B 1.6 m/s^2
C 0.7 m/s^2
D 6.5 m/s^2

89. On Saturday, it was 95°F in downtown Charlotte. Which of the following would be cooler even though it is very hot?
A a city street
B the forest
C the top of the tallest building
D the inside of a parked car

90. When precipitation occurs, much of it goes into the ground as _____.
A transpiration
B runoff
C surface water
D groundwater

91. Which of the following air masses form over polar regions?
A equatorial air masses
B tropical air masses
C Arctic air masses
D source regions

92. When air masses are not moving, the space between the masses is called a _____.
A stationary front
B cold front
C warm front
D front

ANSWER SHEET
EOG 5th Grade SCIENCE — PRACTICE TEST 2

Name_____

INSTRUCTIONS:

1. Fill in your name at the top of this page.
2. Tear out this page.
3. Answer each question and fill in the appropriate bubbles (A, B, C, or D) on this sheet.
4. Once your teacher grades your answers, circle the numbers of your missed questions on the sheet titled "Practice Test 2 Breakdown."
5. By looking at the circled numbers on the breakdown sheet, you will be able to tell which areas (chapters) you need to study.

1. (A) (B) (C) (D)	24. (A) (B) (C) (D)	47. (A) (B) (C) (D)	70. (A) (B) (C) (D)
2. (A) (B) (C) (D)	25. (A) (B) (C) (D)	48. (A) (B) (C) (D)	71. (A) (B) (C) (D)
3. (A) (B) (C) (D)	26. (A) (B) (C) (D)	49. (A) (B) (C) (D)	72. (A) (B) (C) (D)
4. (A) (B) (C) (D)	27. (A) (B) (C) (D)	50. (A) (B) (C) (D)	73. (A) (B) (C) (D)
5. (A) (B) (C) (D)	28. (A) (B) (C) (D)	51. (A) (B) (C) (D)	74. (A) (B) (C) (D)
6. (A) (B) (C) (D)	29. (A) (B) (C) (D)	52. (A) (B) (C) (D)	75. (A) (B) (C) (D)
7. (A) (B) (C) (D)	30. (A) (B) (C) (D)	53. (A) (B) (C) (D)	76. (A) (B) (C) (D)
8. (A) (B) (C) (D)	31. (A) (B) (C) (D)	54. (A) (B) (C) (D)	77. (A) (B) (C) (D)
9. (A) (B) (C) (D)	32. (A) (B) (C) (D)	55. (A) (B) (C) (D)	78. (A) (B) (C) (D)
10. (A) (B) (C) (D)	33. (A) (B) (C) (D)	56. (A) (B) (C) (D)	79. (A) (B) (C) (D)
11. (A) (B) (C) (D)	34. (A) (B) (C) (D)	57. (A) (B) (C) (D)	80. (A) (B) (C) (D)
12. (A) (B) (C) (D)	35. (A) (B) (C) (D)	58. (A) (B) (C) (D)	81. (A) (B) (C) (D)
13. (A) (B) (C) (D)	36. (A) (B) (C) (D)	59. (A) (B) (C) (D)	82. (A) (B) (C) (D)
14. (A) (B) (C) (D)	37. (A) (B) (C) (D)	60. (A) (B) (C) (D)	83. (A) (B) (C) (D)
15. (A) (B) (C) (D)	38. (A) (B) (C) (D)	61. (A) (B) (C) (D)	84. (A) (B) (C) (D)
16. (A) (B) (C) (D)	39. (A) (B) (C) (D)	62. (A) (B) (C) (D)	85. (A) (B) (C) (D)
17. (A) (B) (C) (D)	40. (A) (B) (C) (D)	63. (A) (B) (C) (D)	86. (A) (B) (C) (D)
18. (A) (B) (C) (D)	41. (A) (B) (C) (D)	64. (A) (B) (C) (D)	87. (A) (B) (C) (D)
19. (A) (B) (C) (D)	42. (A) (B) (C) (D)	65. (A) (B) (C) (D)	88. (A) (B) (C) (D)
20. (A) (B) (C) (D)	43. (A) (B) (C) (D)	66. (A) (B) (C) (D)	89. (A) (B) (C) (D)
21. (A) (B) (C) (D)	44. (A) (B) (C) (D)	67. (A) (B) (C) (D)	90. (A) (B) (C) (D)
22. (A) (B) (C) (D)	45. (A) (B) (C) (D)	68. (A) (B) (C) (D)	91. (A) (B) (C) (D)
23. (A) (B) (C) (D)	46. (A) (B) (C) (D)	69. (A) (B) (C) (D)	92. (A) (B) (C) (D)

PRACTICE TEST 2 BREAKDOWN

Chapters	Related Problems
1—Scientific Inquiry	1, 2, 3, 4, 78, 79, 80
2—Understanding Force and Motion	11, 18, 21, 24, 26, 29, 30, 34, 35, 47, 52, 57, 64, 65, 67, 81, 82, 83, 85, 87, 88
3—Matter and Energy	28, 31, 32, 33, 46, 48, 49, 56, 66, 68, 71, 77
4—Understanding Weather and Climate	36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 69, 84, 86, 89, 90, 91, 92
5—Living Organisms	5, 6, 7, 8, 9, 10, 12, 14, 15, 22, 23
6—Populations and Ecosystems	13, 16, 17, 19, 20, 25, 27, 50, 51, 53, 54, 55, 58, 59, 60, 61, 62, 63, 70, 72, 73, 74, 75, 76, 84